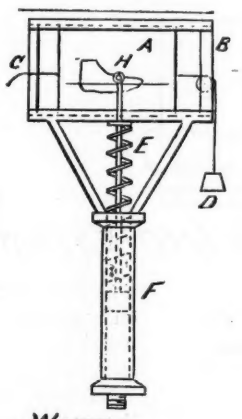
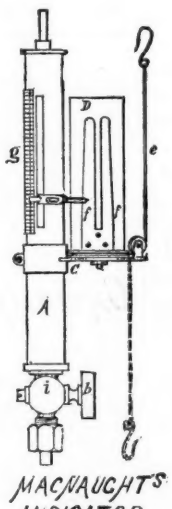
AMERICAN MACHINIST

A JOURNAL FOR MACHINISTS, ENGINEERS, FOUNDERS, BOILER MAKERS, PATTERN MAKERS AND BLACKSMITHS.

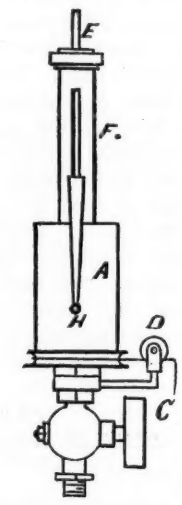
VOL. 2, No. 32. WEEKLY. | NEW YORK, DECEMBER 20, 1879. | $3.00 per Annum. SINGLE COPIES, 6 CENTS.



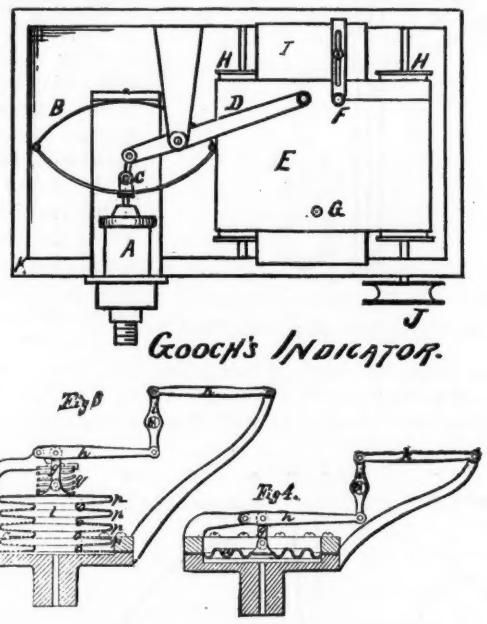
WATTS INDICATOR



MACNAUGHT'S INDICATOR



CONCENTRIC DRUM.



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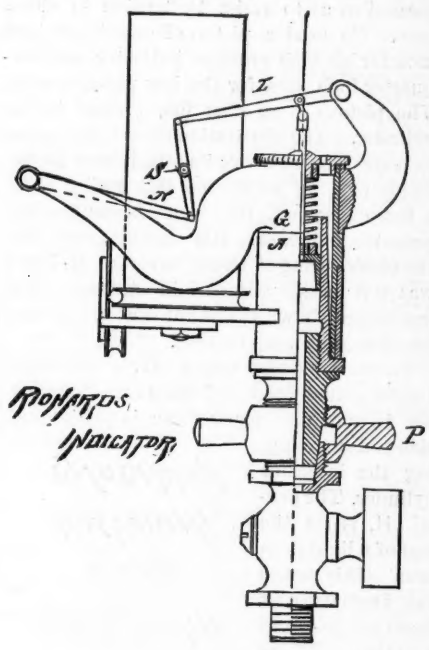
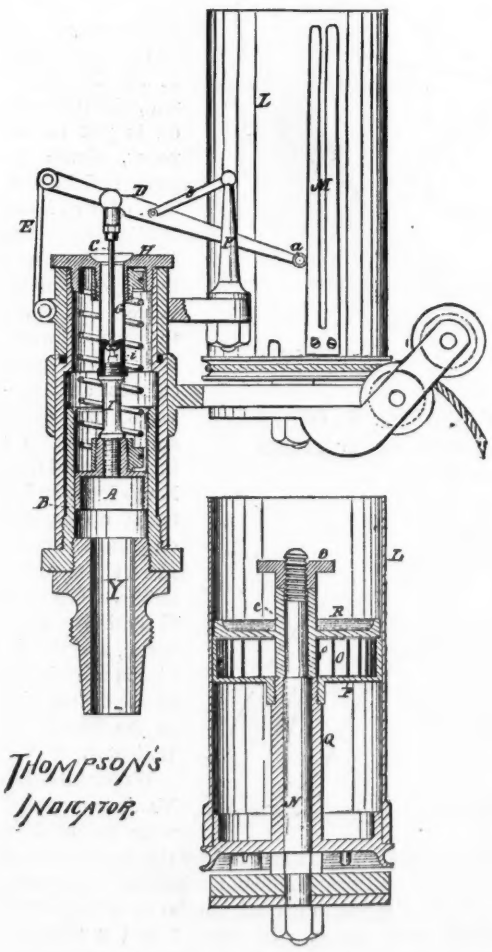


ROBARTS INDICATOR

WIEGAND & LEVAN'S INDICATORS



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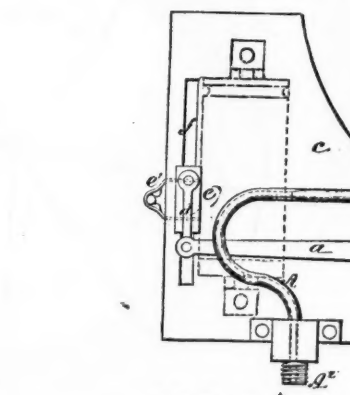
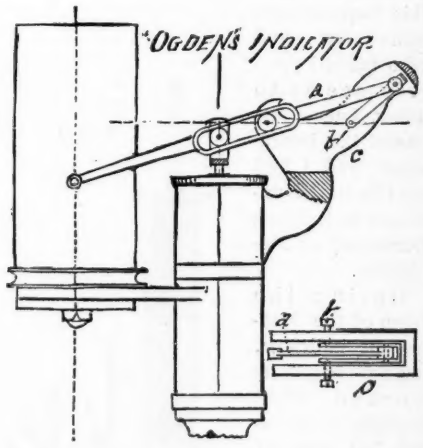
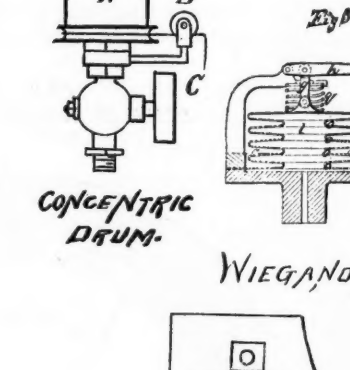


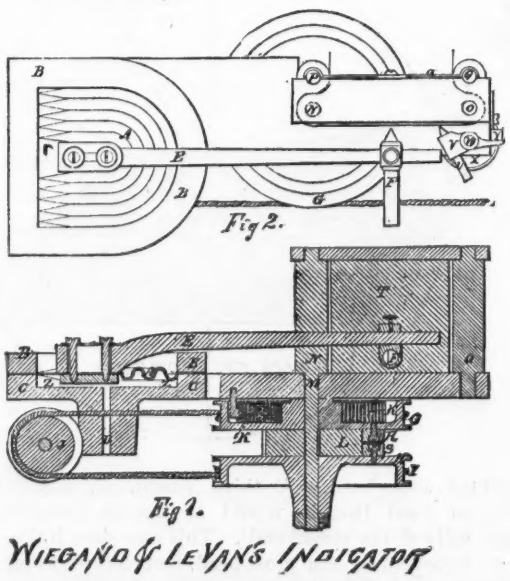
MINOT & RAES INDICATOR.



OGDEN'S INDICATOR.



TABER'S INDICATOR



WIEGAND & LEVAN'S INDICATOR

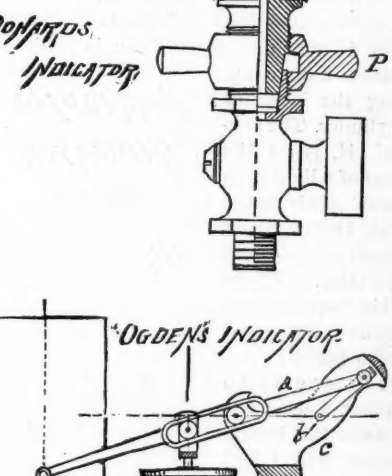


Fig. 6

Extracts from Chordal's Letters.

Mr. Editor:

* * * * In a recent letter to you I spoke of the desirability of the Indicator being gotten up in more popular form.

My letter to you has resulted in my receiving many letters from many parties, referring to some plan they had. I was given information, and I was asked for information as though I knew all about the indicator matter. I know just enough about the subject to see that many are re-traversing old paths; that many know nothing of what *has* been done; and that some sort of a *resume* of the history of indicators would be of service to many, besides securing me against much idle inquiry. I hand you herewith sketches, and these with the following descriptions constitute my complete stock of knowledge of indicators. Many others are better posted, and this may be the means of bringing them forward. * * * *

WATT'S INDICATOR, as shown, combines a cylinder, spring loaded piston, pencil on end of piston rod; sliding board moved by crosshead, paper tacked on the board, and a weight to cause return movement of board. Springs were finally used instead of the weight. Oil was poured on top of the piston to make it tight. Bear this in mind. Watt's engines were real condensing engines, and his cards would show thirteen pounds below the atmospheric line, while they showed but three or four pounds above. It will be seen that this instrument covers the whole field. The piston records its movement on moving paper. There are intimations that Watt simply watched the end of the piston rod in seeking information, and that later inventors added the paper. Watt was one of the men born in order that little in his art should be left undone, and every letter he wrote to friends spoke of the instrument as having a paper board. Considering the pressures and piston speeds prevalent in Watt's time, it is safe to say that his indicator was as perfect as any of our day. * * * *

MACNAUGHT'S INDICATOR. Watt's indicator was used mostly by Watt himself. Macnaught, of Glasgow, took it in hand to make the instrument popular among engineers, and he

was successful. His instrument was the standard until the invention of the Richards'. His improvements consisted in adapting the parts to slightly quicker piston movements and higher pressures. He introduced the paper drum substantially as it is used to-day. He made two instruments; one for condensing engines, the other for non-condensing engines. He pulled on the springs instead of pushing as we do now-a-days. The difference, therefore, between his two instruments was—in that one had the spring between its piston-rod fastening and the upper end of the cylinder, while the other had the spring attached to the lower end of the cylinder. The prevailing motion of the indicator piston, when used on the two classes of engines, was kept in view, and the spring located so as to resist by tension in either case. He used a piston of one-eighth inch area for his high pressure indicator, and one-quarter inch area for the low pressure ones. The pistons were *close* fits, *ground* to the cylinder. The illustration shows the spring as being located above its attachment to the piston-rod. If we assume this spring to be a tension spring, this is a Macnaught low pressure indicator. His spring-drum had the clock spring of to-day to return it, but it was not easily adjusted in stiffness. The instrument shown in the cut is as it was used by all engineers up to 1863. * * * *

THE CONCENTRIC DRUM. Over this name I show a modification of Macnaught's indicator, in which the paper drum is placed outside and surrounding the indicator cylinder. The pencil, H, is on the end of a light drop arm. This makes the instrument more compact and portable. Where this improvement came from, and who made it, nobody seems to know. I never saw one of the instruments, and I find the illustration unnamed in Knight's Dictionary of Mechanics.

During the reign of the Macnaught indicator, many engineers worked slight changes in its detail, but none of them worthy special notice.

GOOCH'S INDICATOR. Here we have an entirely new variety. In it, for the first time, the piston motion is multiplied by a lever. This allowed a heavy stiff spring, short piston travel, and larger area of piston. The parts in motion are lighter than have ever been put in modern instruments, but the pencil moves in curves and draws the card upside down. The spring B, it will be seen, is of the elliptical form, made of flat steel, like a buggy spring. This instrument was devised for quick running locomotives, and could, of course, have been supplied with the usual paper drum. The inventor preferred, however, to get a continuous diagram on a long strip of paper moved by suitable feed rollers over the table I. The instrument was enclosed in a box which could be closed while the indicator was working. An adjustable pencil, F, drew continuously the atmospheric line. The paper was fed by means of the pulley J, which was continuously revolved in one direction by the engine. A very little study will show that correct diagrams of piston motion was not multiplied. Full descriptions can be found in Appleton's Dictionary of Mechanics. * * * *

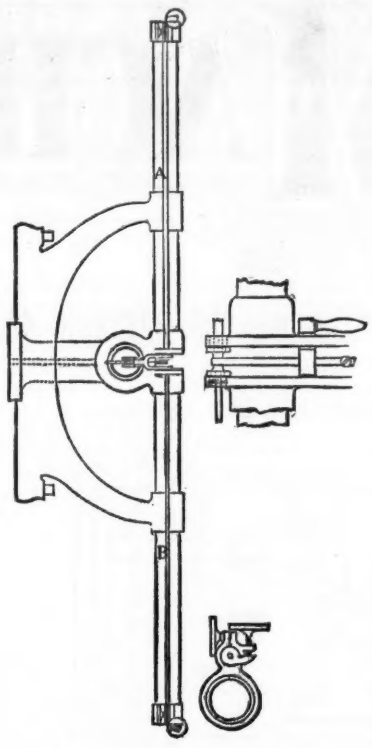
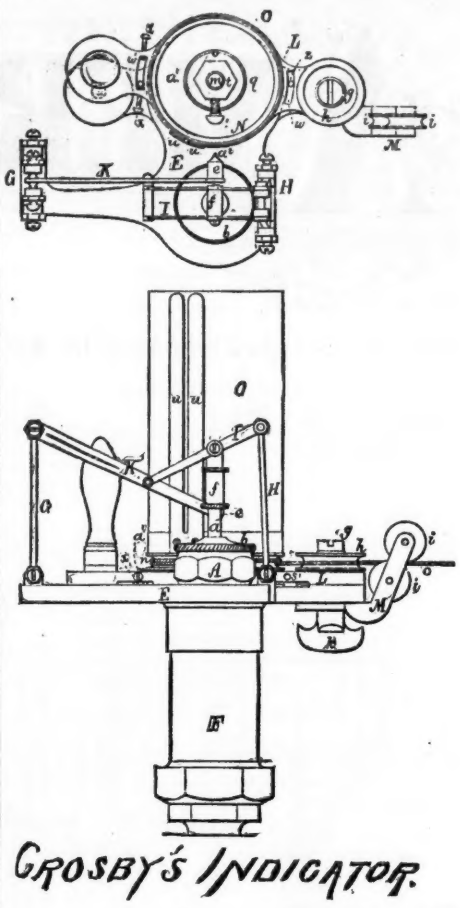


FIG. 7.—SWEET'S PROPOSED INDICATOR.

THE RICHARDS INDICATOR was invented in 1861, or thereabouts, by Charles B. Richards, of Hartford, Conn. It struck the key-note of perfection, and quickly became the sole instrument in use. It was and is manufactured by Elliot Bros., London, and the American Steam Gauge Co., Boston. Richards' instrument represents happy thought and excellent constructive skill. In it are combined the cylinder of Watt; the paper drum of Macnaught; the multiplying lever of Gooch, and the old beam engine parallel motion of Watt. He produced an instrument which may be considered perfect. In his first instruments, the housing, G, which furnishes bearings for the pencil system, was caused to strike, in its rotation, a spring fixed to the cylinder casing A. This spring served to push the pencil away from the paper when not overcome by the pressure of the operator's hand. This was abandoned, and a more satisfactory substitute found in bringing the rotation of the housing to a definite stop at a point where the elasticity of the pencil lever would give the right pressure and a constant pressure on the pencil. Formerly a brass pencil was used, and it drew its lines on specially prepared metallic paper. In late years, however, most engineers have used a small wooden pencil, whittled from a hard Faber, and screwed through the holes to be carried on without unhooking any strings, thus:



GROSBY'S INDICATOR.

DARKE'S DRUM STOP.—Ratchet teeth are cut in a flange on the bottom of the paper drum. A pawl on the reach arm is held into the teeth by a light spring. A cam-shaped lug on the sleeve part of the housing *c* will, when the pencil is put to the paper, release the pawl and hold it out of action. While the pencil is against the paper the paper drum revolves; but when the pencil is swung back the pawl catches and prevents the drum spring from acting. The cord then hangs loose and is taken up by the crosshead movement at each stroke. The pawl is entirely automatic, and the device is reliable. It is applicable also to the Thompson Indicator. * * *

WIEGAND & LEVAN'S INDICATORS were patented in 1864. Figs. 1 and 2 show the instrument as a continuous indicator. Instead of a piston a diaphragm is used, similar to a diaphragm steam-gauge. In Figs. 1 and 2 this diaphragm is in itself a peculiar arrangement, one edge being *un*corrugated. This gives the diaphragm a tilting motion while distending, and a lever attached to such a diaphragm contains all the elements of a multiplying device without links or pivots.

This instrument has no parallel motion. The paper is a strip fed continuously by the rolls, N, O, actuated by pawls, R, S, which act in opposite directions, being attached to cord-disks, G and L. The crosshead cord is carried around the lower disk, then over idler, J, then on to the upper disk, G, which contains a recoil spring, K. Cross-head thus

HARRISON'S INDICATOR AND DIAGRAMS.

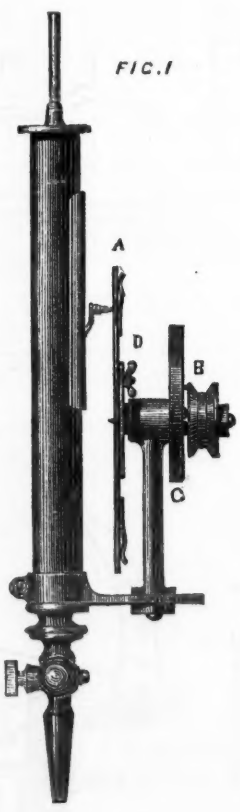
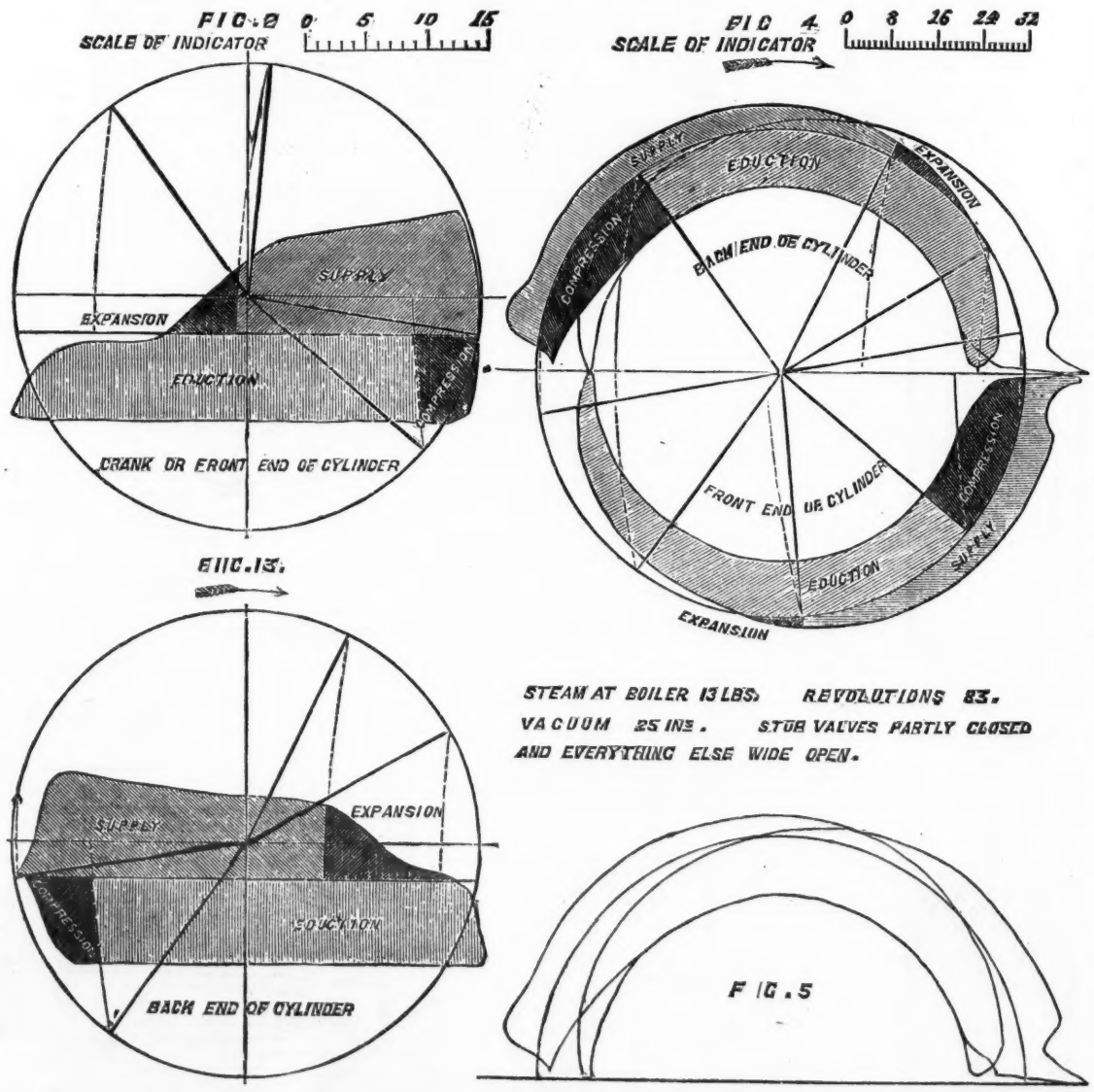


FIG. 1



STEAM AT BOILER 13 LBS. REVOLUTIONS 83.
VACUUM 25 INS. STOP VALVES PARTLY CLOSED
AND EVERYTHING ELSE WIDE OPEN.

FIG. 5

rotates the two disks alternately in opposite directions, while their pawls move ratchet L, and feed roll N continuously in one direction. V is a pencil, adjustable vertically, for drawing the atmospheric line. The parties who brought forth this species of indicator did not propose to confine themselves to a strip record, or to a multiplying diaphragm, or to a "minus" of parallelism. They devised and patented many varieties. Fig. 4 shows a common concentric diaphragm, with common parallel motion. They also proposed to load this diaphragm with a coil spring. Fig. 3 is another of theirs, having a distensible chamber of the accordion style. It is to be used with or without the spring *q*. At the date of this invention, Mr. LeVan was as well posted on indicators as any one in the country, and it would be worth something to have him give his experience with these nondescripts. The "business end" of Figs. 1 and 2 looks as though there might be material for the "vaporgraph" in them. * * * *

MINOR AND RAE'S INDICATOR. This instrument uses a hollow spring A, like a Bourdon steam gauge. Steam enters this spring; tends to change its section from flat to round, and, in doing this, tends to make all sides of the tube the same length, which tends to straighten the tube out, thus producing the motion. The parts shown are easily understood. In order to provoke an expression from the inventors, who ought to tell about the thing, I will, as I did in a former letter, venture the opinion that the spring won't respond quick enough for an indicator. This indicator was patented in 1876. The inventors are residents of New York and Brooklyn respectively. * * * *

THOMPSON'S INDICATOR was invented and patented in 1875 by Mr. Joseph W. Thompson, the well-known engineer of the Buckeye Engine Co., of Salem, Ohio. This instrument is a refinement of the Richards. A lighter and simpler parallel motion was devised by Mr. Thompson, and the drum-spring has a winding disk R, locked by the milled nut S, which allows the tension of the drum-spring to be conveniently adjusted to suit the piston speed of the engine. This indicator is made by the American Steam Gauge Co., and is now the standard of this country, having largely displaced the Richards.

Watt kept oil on his piston to keep it tight against "vacuum suction;" Macnaught ground his piston in; Gooch carefully fitted the piston as frictionless and leakless as possible; Richards, dealing mostly with pressures above the atmosphere, made the piston of the exact area wanted, and bored the cylinder large so steam would blow through. No leakage of piston will effect the pressure against that piston unless that leak of itself succeeds in reducing the pressure under the piston, or succeeds in causing a pressure above the piston. Thompson followed the same plan: loose piston of precise area. *Now* the naval engineers are demanding cylinders to fit the piston tightly, so that the vacuum will not be vitiated by leakage. This is going backwards. In the last year a demand has sprung up for indicators to work under pressures, as high as one hundred and fifty lbs., and the usual springs would not do it. A spring for such high pressures proved a troublesome thing to make. Mr. Thompson appreciated the situation and mastered it with ease. He makes the inlet, Y, a second cylinder having just half the area of the upper cylinder. A long piston rod is provided which attaches to a piston in the small cylinder.

The same springs as usual are used, and their scale is thus doubled. A spring, sixty pounds to the inch with the large piston, becomes 120 pounds per inch with the small piston.

HARRISON'S INDICATOR AND DIAGRAMS.—This is a "thing by itself," and I cannot do better than give you entire the inventor's letter written from Hong Kong, in 1875, to the editor of *The Engineer:*

"SIR.—I beg to enclose a plan of indicating steam engines that I think is worthy of some attention from those interested in their performance.

"Fig. 1 is an elevation of the disk indicator as converted from a common one by me. Instead of the usual barrel a disk A is used, thus exposing a rotary plane instead of a rotary cylinder to the pencil. The disk A is on the same shaft as the pulley B, and the latter receives the motion from the engine to be indicated, having a return spring C. The diameter of pulley B is such that it will move the disk A exactly half a revolution when connected to the engine—also the disk A can be moved in relation to the pulley B exactly half a revolution by means of a radical slit and pinching screw at D.

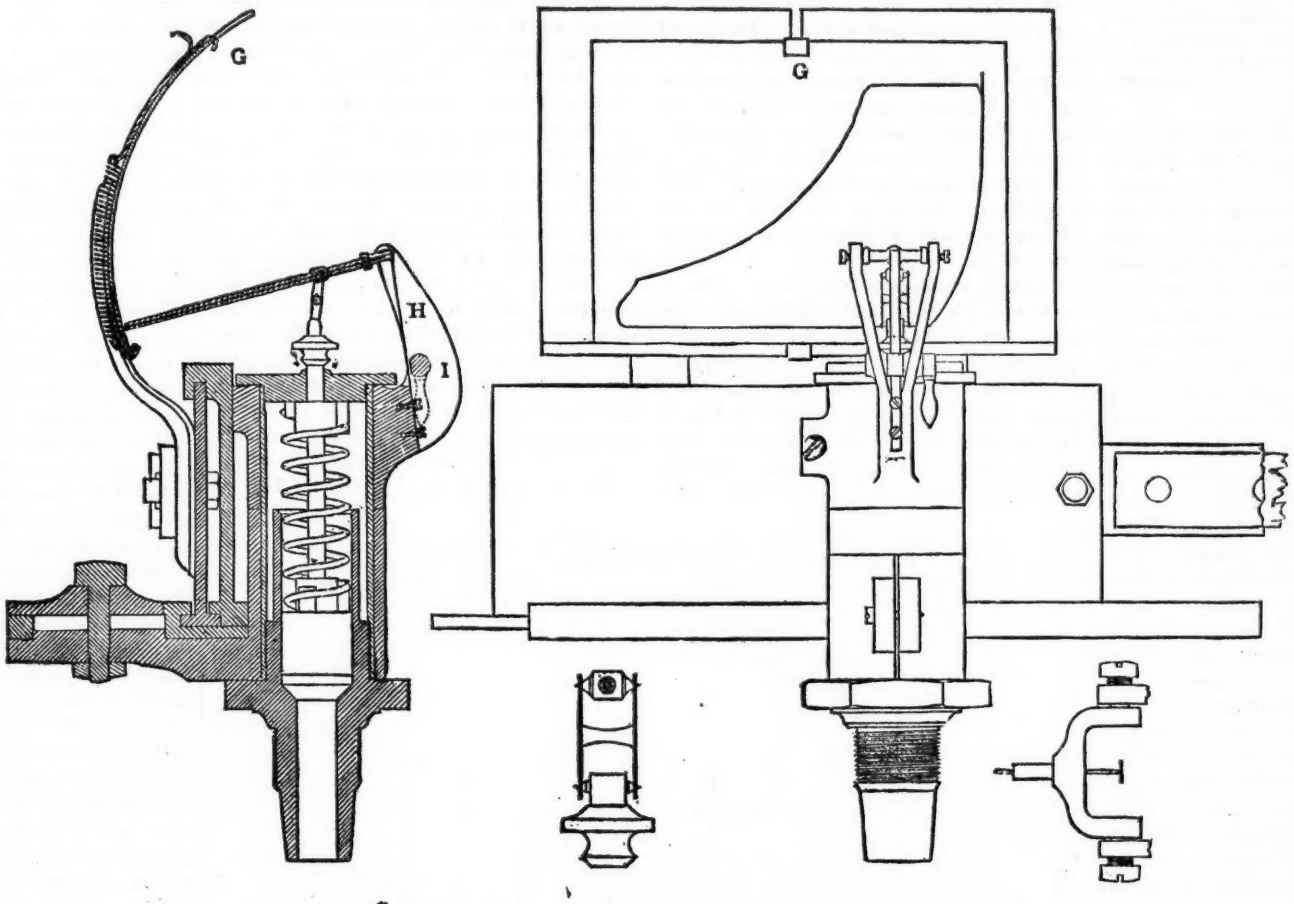
"Let now the pencil of the indicator be applied to the disk A, and the string to the engine in the usual manner—the indicator cock being shut—the pencil will trace a semi-circle, which will be the atmospheric or datum line of the diagrams, or path of crank; next complete the cards in the usual way from both ends of the cylinder. After this the disk A can be moved round half a revolution, and two other cards taken on the same paper—but the object sought for in this operation is not to increase the number of cards, but to place one pair of them in a geometrical position with regard to the crank for a complete revolution of the engine. Either of the pairs of cards can now be selected for ascertaining the mean pressures, and the cards for the front and back ends of the cylinders are placed in proper position corresponding to the crank circle of the engine.

"We have now the means of finding the relative positions of crank and piston, corrected for obliquity of rods for each half revolution of the engine, as shown at Fig. 4. This information cannot be ascertained from the common diagrams without some doubtful geometrical tests—these tests are ably given in Mr. Burgh's book on 'The Indicator Diagram,' in which he concludes thus: 'Indeed this geometrical test is the only method that can be adopted to detect fictitious indicator diagrams, and the imperfect mechanism of the steam engine.' In this remark all will agree, but I prefer that the engine performs its own geometry as far as possible, being strictly a geometrical machine—hence the disk method of indicating.

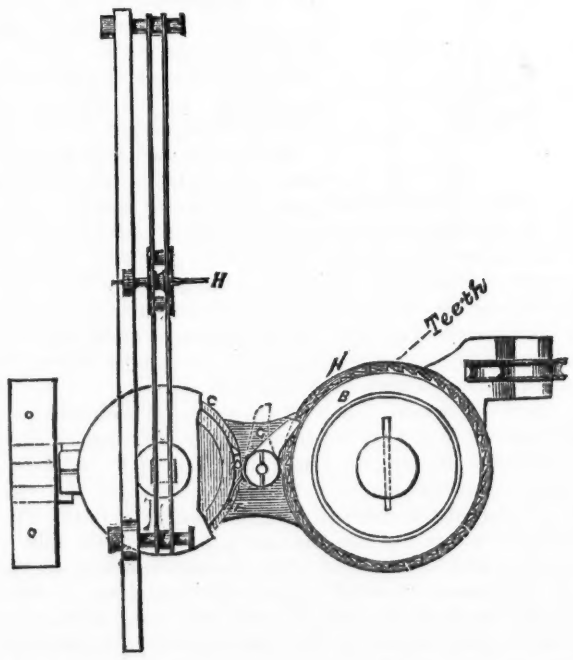
"Figs. 2 and 3 are tracings of a pair of common diagrams, and Fig. 4 is an original pair taken by the disk indicator; they were taken from the same cylinder and at as nearly the same time as possible, and by two different indicators, one of 10 lbs. and the other of 20 lbs. to an inch. The positions of piston and crank are given from actual measurement of the engine, and for comparison of the methods of indicating. In the disk diagram the atmospheric line represents the path of crank—not the length of the cylinder—as in the common diagram, but in describing the semi-circle, the diameter of it, or length of cylinder is produced also.

"The actual length of the steam or other lines in these cards are extended in proportion of the diameter to semi-circumference of a circle; this extension gives them an advantage over the common diagrams, for the reason that the errors in the diagram are magnified, and the important points in the card, such as opening and shutting of slide ports, etc., appear more distinctly defined. The steam distribution upon the crank pin is often affected by lengths of rods beyond what appears in common diagrams; the effect produced by long or short rods is by the disk method of indicating clearly shown.

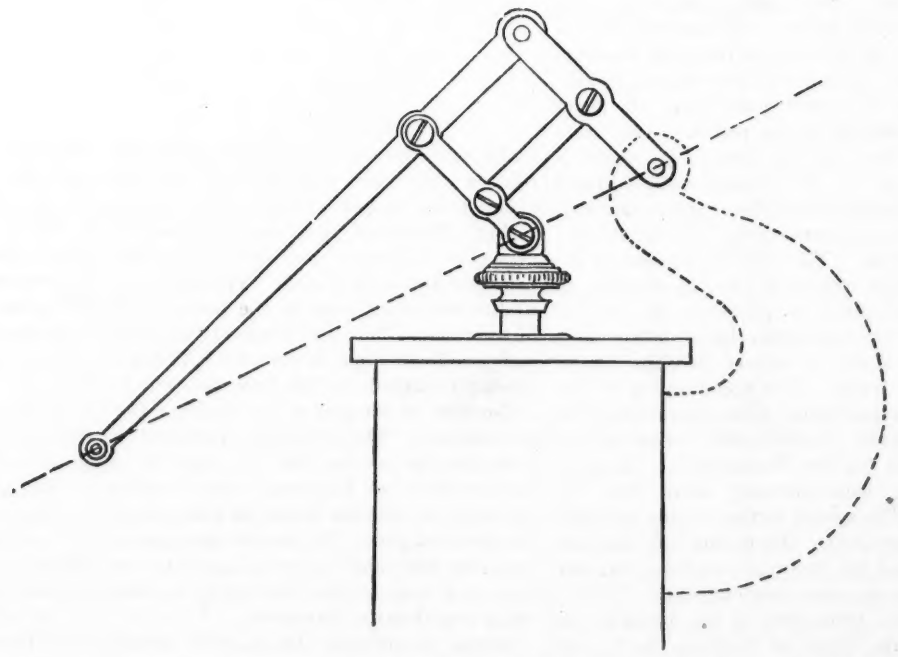
"In the engines these cards were taken from, the stroke is 18 in., and connecting rod 3 ft., hence, twice the stroke or disk of datum circle equals length of



SWEET'S INDICATOR.



DARKE'S DRUM STOP



RICHARDS' INDICATOR B.

rod, or radius to be used in determining the position of piston from the diagram. All the points to be determined must be referred to the datum circle to define the positions of piston, etc., as is shown in Fig. 4.

"The paper is secured in position and held by the four clip springs at the back of the disk A while the cards are taken.

"The knife joint in the pencil-holder is dispensed with, the holder is thus shortened, and all vibration and chattering of pencil avoided. The pencil being held in a brass spring, as shown in Fig. 1, it will be seen that most common indicators can readily be converted into disk or common ones at will, as has been done in this case.

"The disk card can be more readily divided for obtaining mean pressures than common ones, as the divisions of a circle are constant, while the length of the ordinary piston diagram is variable. Fig. 5 shows a pair of cards divided by a perforated divider, ready for measurement; of course all measurements for mean pressures are taken radially from the center of the circle or diagram. H. HARRISON."

* * * * * * *

RICHARDS' INDICATOR B.—Over this name I show a device gotten up by Mr. Richards as a perfect parallel motion. The common devices are simply geometrical approximations. This will be recognized as a pantagraph motion, in which the true line of the piston motion is multiplied in length, and transferred to the paper. This indicator has never been in the market. A single one was made by Mr. R. and sent to the late Paris Exposition, where, after receiving a gold medal, it was captured by one of the learned institutions. * * * *

OGDEN'S INDICATOR.—This instrument was invented and constructed by Mr. F. Ogden, of Mansfield, Ohio. It is a new parallel motion which those interested can analyze for themselves. It should be readily understood from the drawing. It is constructed on the regular Richards plan in most particulars. The housing arm *c*, is hollow, and encloses the end work. The exposed parts consist simply of the working end of the pencil arm and the upper end of piston-rod. Neat rollers at the two important pivots. This instrument does superior work at high velocities. Mr. Ogden also applies a device which automatically withdraws the pencil after one line has been traced; at the same time the pencil may be held to its work as long as desired. * * * *

CROSBY'S INDICATOR was patented in 1879 by George H. Crosby, of Boston. There are several novel features about it; the cylinder has nothing attached to its upper end, being left free to expand without affecting the pencil system. The housing arm is attached entirely to the jacket. The new parallel motion will be understood from the drawing. The pencil system does not revolve, and the pencil is not moved to the paper; the paper drum is moved to the pencil. The drum spindle has a bottom flange, L, which is pivoted at *g*. This flange really forms a lever, a handle being placed at the other end. A stop in a segmental slot limits the "push" of the drum. To avoid the resistance the cord would offer this pushing motion, an extra cord pulley is placed on the pivot *g*. To make the instrument right or left handed, the pivot *g* may be placed in either end of the base lever. The recoil spring of the drum is a long spiral spring surrounding the drum-spindle, provided with "winding up" nuts at the top like Thompson's. A spring holds the drum normally away from the paper. The special virtues of this indicator are not apparent. Old results only are produced, and the means are anything but simple, some are even questionable. * * * *

TABER'S INDICATOR is the invention of Mr. Harris Taber, of Corning, N. Y., and was patented in 1878. It will be understood at once. The curved slot in the piston-rod, running over a roller, corrects perfectly the curvilinear tendency of the pencil motion. The arm, it will be seen, is a skeleton. This is the lightest and most perfect movement yet produced, and the simplest. This instrument has a future beyond all doubt. I have seen cards taken by this instrument at 390 revolutions per minute 70 pounds pressure, *with a thirty-two pound spring*, and it was all that could be desired. The construction of the curve is simple. When the indicator is all done but the curve, a straight-edge may be laid on the drum and the pencil drawn along its side while a neatly-fitted scratch-awl is pushed, through the guide-pin hole, against the curve blank. The guide is capped over, and the whole top work revolves as is usual. * * * * *

SWEET'S INDICATOR.—This is the latest, and is almost of a new genus. Like all other indicators this one is built on an old Richards' instrument; as soon, however, as the foundation is left the transformation begins. First, there is no parallel motion. It is rendered unnecessary by the bold act of suppressing the tendency of the pencil to curve its lines. The surface of the paper, and its motion is in the same line as the axis of the pencil lever. The paper is sprung into its concave seat and then clipped. The paper reciprocates after the manner of Watt. The pencil lever is a fine tube, and through it passes a copper-wire which is pointed and forms the pencil. The wire projects through the rear end of the tube, and is there pressed by a flat spring. A cam lever throws this spring into action or out, one or the other, no half-way points. The more one looks into this instrument the more admirable features one sees. * * * * *

SWEET'S PROPOSED INDICATOR.—This is *not* to be built on an old foundation. New bottles are to be used. The usual spiral spring is omitted, and in its stead the pencil arm is caused to twist a long square steel spring rod, A or B, as shown in Fig. 7. The two rods differ in size. For low pressures the small rod may be used, for high pressures the larger rod, and for still higher pressures both rods. Instead of varying the rods, a single one may be used, the end clamp being moved to shorten the torsion spring. Torsional resistance increases inversely as the length, and one rod can thus be set for any desired scale. The direct connection causes an error in the transmission of velocities. The relative velocity of piston and pencil would not be constant. This was quickly remedied; not by invention but by a discovery on the part of Mr. Hasley, a Cornell student. The execution consisted in arranging the parts so that the angle of vibration above the horizontal would exceed the angle of vibration below, in a certain ascertained relation. The torsion spring opens up a new field, and it is to be hoped that we may soon hear of this instrument in some other way than as "proposed." * * * *

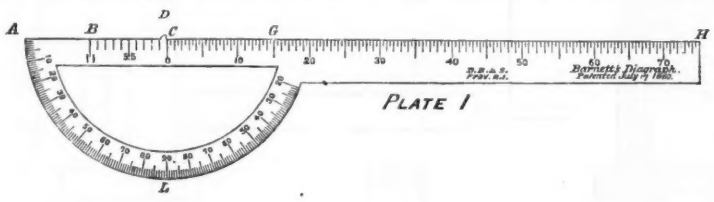
OTHER VARIETIES.—Dr. Lardner devised an instrument in which paper was drawn past several pencils, of different colors, floating in siphon mercury tubes connected respectively with cylinders, steam chests, steampipes, and condensers. The relation of the colored lines exhited the relation of pressures. Nothing good came of it. Bourne devised an indicator which he called a power meter. Each end of the indicator cylinder was connected with one end of the engine cylinder. The pencil was reciprocated by positive mechanism, and marked a moving strip of paper. The office of the indicator piston was to move a delicate slotted link which was to determine the length of the pencil motion. The indicator piston thus became directive instead of executive.

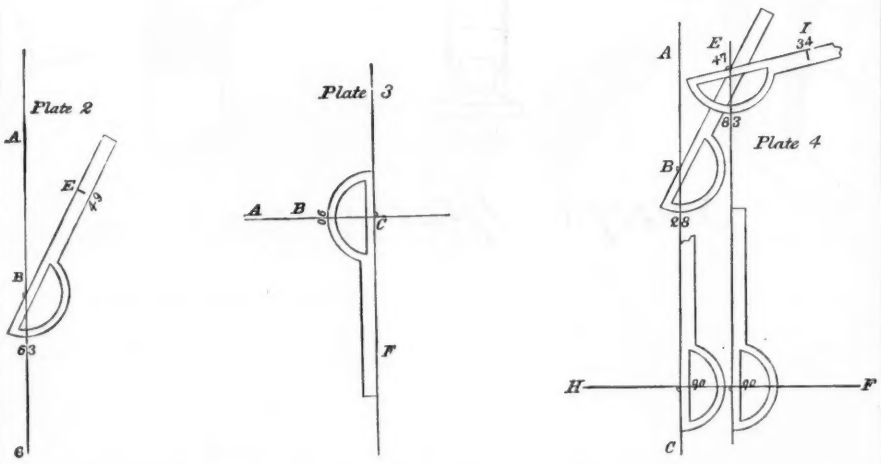
Ashton and Storey invented a similar device in which bush-gearing took the place of the link as an integrating element. Little of value can be gotten from these devices. * * * * *

Aside from indicators, Mr. Editor, there are many useful and interesting accessories to them, and if nothing happens, I will refer to them in my next letter. * * * * *

Very respectfully,

CHORDAL.





The Diagraph.

The accompanying illustrations represent a most useful addition to an ordinary box of drawing instruments. Nearly every draughtsman knows the great difficulties which are encountered in laying out angles by the aid of the protractors in general use. First, the exact center must be found, which is seldom adjusted so as to correspond both on the instrument, and the paper. Second, when the centre has been adjusted, the point for the required angle has to be marked either with a pencil or a pricker, hence it will be seen that the chances for variation are doubled; moreover if the light is poor when this operation is performed, the draughtsman has great difficulty in finding and laying out the points. The instrument, shown in Plate 1, supplies this deficiency, and gives, at one adjustment, both the direction and length of a given line.

This instrument is valuable in drawing diagrams and platting surveys, by which the operation of platting is increased *fourfold*. By the aid of a pair of compasses for circles it will be found an improvement upon an entire set of surveyor's instruments, doing the same work with greater accuracy and facility. The construction will be readily understood from the illustration, Plate 1. It is made of German silver and may be described as follows: The circular protractor A, L, G, is 4″ in diameter, and graduated into degrees. The rule A, G, H, (which is an extension of the diameter A, G,) is divided from the center C, into tenths of an inch, which are subdivided to show twentieths, also. A vernier C, B, is located on the left center. A small nib or projection is located at D, to assist in locating the exact center. The angle at D, at which the nib and rule meet, is one-fiftieth of an inch below and to the left of the center, in order that the point of the pencil may be so placed that a line may be drawn directly from the center. Persons accustomed to the use of drawing instruments will readily understand this and other points which will be mentioned in connection with this instrument, and its use. In drawing a line, three things must be given, viz.: The initial point, or center, the direction, and the length. The methods provided in the diagraph are peculiarly direct and plain. In using the ordinary brass circular protractor, the instrument is in the way of the operator so that the pencil cannot reach the proper point. In the diagraph the draughtsman is allowed to begin at precisely the right place which is the exact center of the protractor as described.

In regard to the direction we may say that some meridian or other fixed line is always assumed as the base line of a drawing. On this meridian or base line, when the center and the proper degree of the protractor are set, the adjustment of the protractor adjusts the rule. Or, in other words, when the protractor is set in its proper place, the rule will be found in the proper direction, and the pencil line, drawn along the edge of the rule, starts from the exact center, and is an exact radius of the protractor. The length of the line is laid out directly from the graduated scale on the edge of the rule, without the necessity of transferring. To show the practical utility of the diagraph we will give a few examples.

Example 1, Plate 2. From the point B, in the meridian line A, B, C, to draw a line N, 63°, E, and 49 parts long. Set the pencil point at B; against this point as a pivot, set the corner at center of the protractor, and turn it with the rule towards the N, E, till 63° rests on the line A, B, C. Draw along the edge of the rule to division 49 at E. The line B, E, so drawn is the line required. It begins at B, and makes with A, B, C, an angle of 63° towards the N, E, and is 49 parts long, and thus fulfills all the conditions of the problem. (A small portion of the protractor is not graduated—just where the rule unites with it. In such cases, set the center of the protractor flat against the line and mark a point at 20°, then revolve the protractor from this point the required number of degrees, and draw the line.)

An explanation of the use of the vernier is now in order. On the left of the center, 1.1 inches are set off and divided into ten equal parts, each of which is therefore 11 hundredths of an inch long, which is 1 hundredth longer than the corresponding parts on the right, 2 to 2.2, 3 to 3.3, and so on. To draw a line 27.3 parts long, take on the left of the center or zero point, 3 parts, the number indicated by the decimal figure, and on the right take 27 parts less 3 (24 parts) this will give the required line. Proof.—3 parts on the left are equal to 3.3 on the right, to which 24 parts added make the equivalent of 27.3 parts on the right.

Required, a line 39.6 parts long. Taking 6 from 39 leaves 33. Take 6 parts on the left, and 33 on the right of zero, and the line will be equal to 39.6 parts on the right. When, in the use of the vernier, a very short line is required, for example 2.8 parts, mark off 8 parts from the left, and cut off from it 6 parts on the right, and 8.8 less 6 are 2.8.

(In drawing the line to avoid the nib, begin from the center as usual and then slide the rule till the proper number on the left comes to the beginning point of the line.)

Most of the problems given at the opening of books on geometry and surveying can be done by the diagraph; also the construction and measurement of all figures bounded by straight lines can be effected very readily. Example 2, Plate 3.

From a point F, without a line A, B, C, to draw a line at right-angles to A, B, C. Set the pencil point at F, and feeling against it with the rule, move the diagraph till the center and 90° rest on A, B, C. Then draw the line along the edge of the rule. A line may, in like manner, be drawn, making any other angle, as 60 or 45 degrees. Surveys may be plotted in the usual method, by comparing the courses given in the field notes, so as to ascertain the angles they make with each other. There is less instrumental work in this method, but more mental labor and more liability to error.

It is best to make a new meridian for each new line. This saves the calculation of the angle of deviation, and makes each new line independent of errors in former lines.

Example 3, plate 4. Plot the following lines: 1. N, 28° E, ch. 2. N, 83° E, 34 ch. Solution 1. Draw an East and West line, H F, across the page. Any line at right-angles to this will be a meridian. Draw a meridian line, A, B, C, and draw the first line, B, E, as in plate 2. Solution 2. Through E draw a second meridian line, as in plate 3, and then from the point E, in this new meridian, draw E, I. N, 83°, E, 34 parts. 3. For the third line, draw through I a new meridian, and so

on to the close. The diagraph should be handled with the left hand, keeping the pencil in the right, and when the instrument is adjusted, the fingers should be kept far enough apart to hold it firmly and prevent its slipping or revolving. The operator should study to keep his fingers out of his own way and also the light. The edge of the nib and the part of the protractor in use should be kept unobstructed, in order to see and draw freely and clearly. The pencil should be comparatively hard for durability, and kept well sharpened, using the point as a pivot, and with the recess of the protractor feel against it. Thus the eyes and one hand are left free to guide the protractor.

The diameter of the circle is 4″, and the whole length of the instrument is 9½″. They are furnished either with or without morocco case by Messrs. Darling, Brown & Sharpe, Providence, R. I.

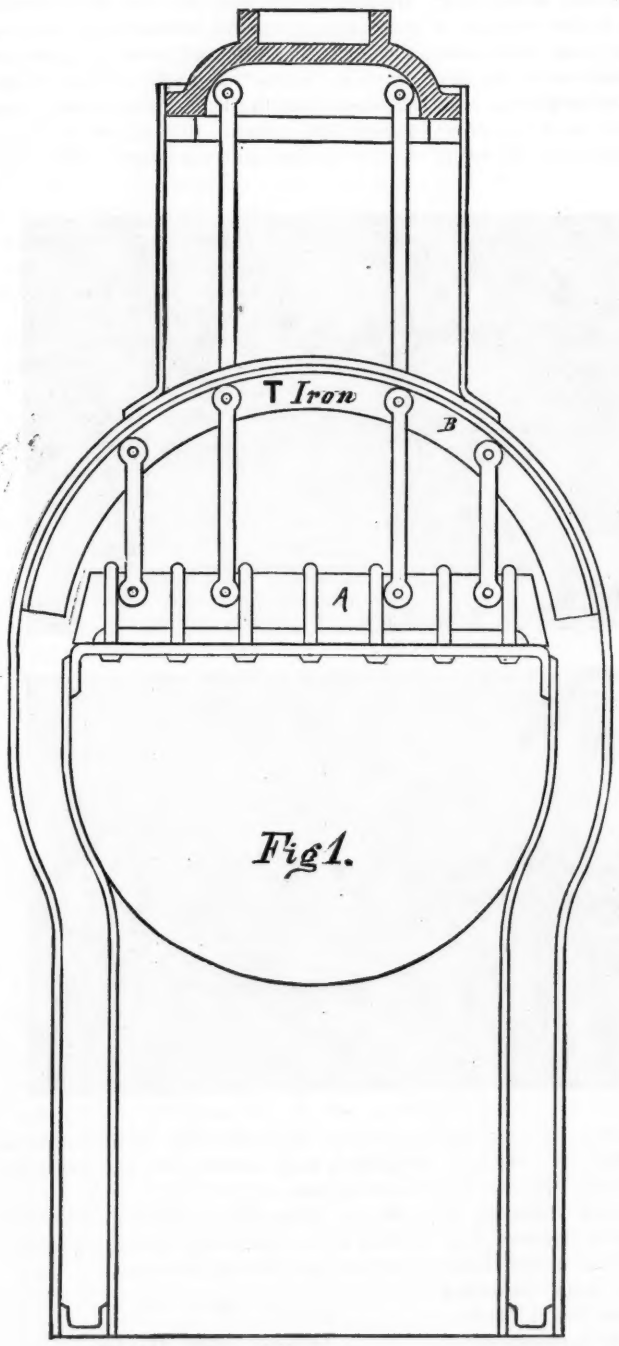


Fig 1.

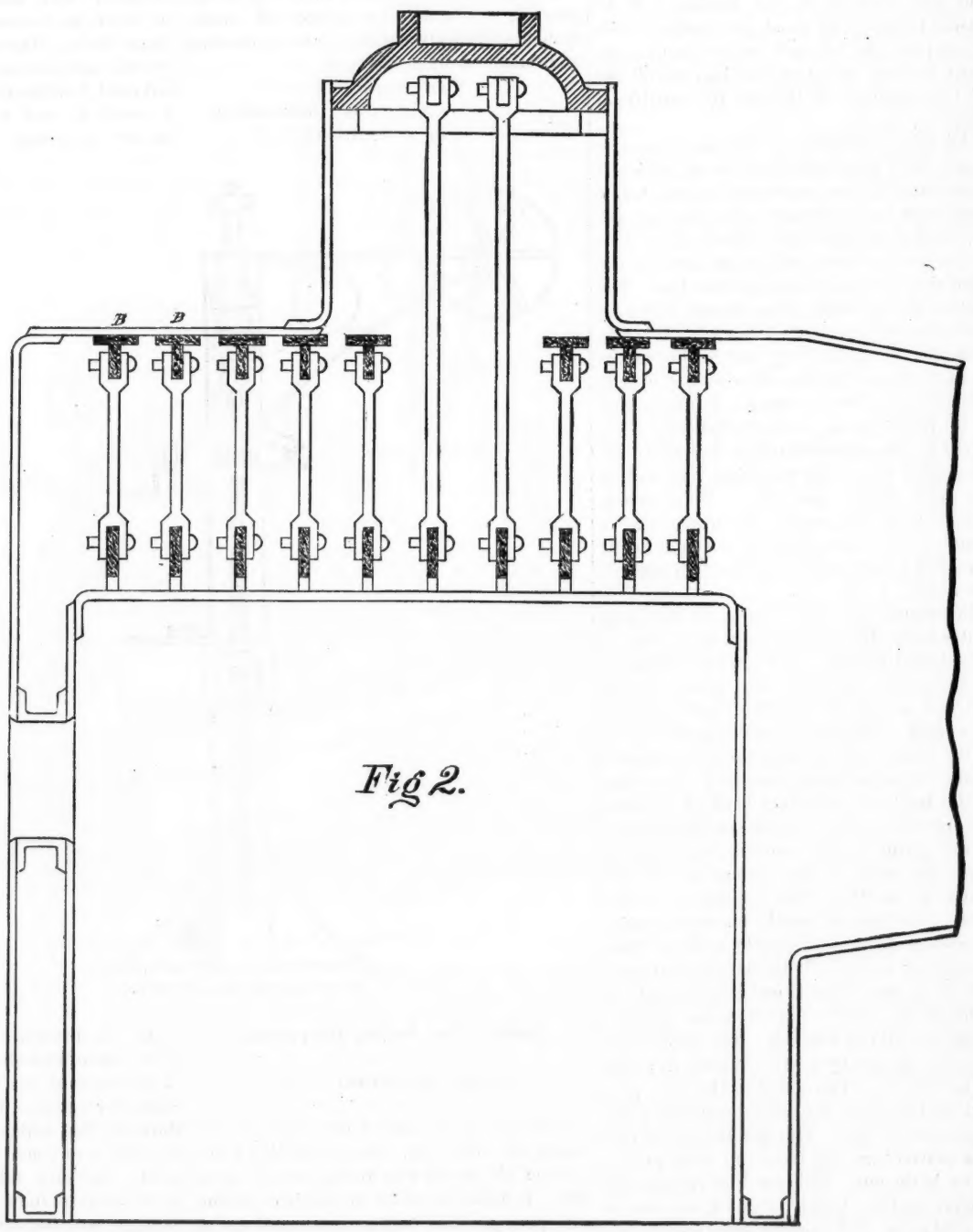


Fig 2.

SIDE VIEW. (Scale ¾″ to a foot.) END VIEW.

Boiler Proportion and Construction, Spacing Rivets, Width of Laps, etc.

BY WM. H. HOFFMAN M. E.

In a previous article on Boiler Proportion where I mentioned the pitching of rivet holes, I referred mainly to *steel* sheets, and wholly to *drilled holes*. Where punching is the system used in construction, the rivet (pitch remaining the same) should be increased fifteen per cent. for steel sheets, and twenty per cent. for iron sheets.

Arranging the rivet holes for double riveting, and adopting the triangular form, or zig-zag pitch, the sides of the triangle should never be equal, but the base on lower row must be that of two right angle triangles, forming, of course, a triangle whose perpendicular is one-half the whole base. Therefore in the case of $\frac{9}{16}$″ steel plates (96″ shell) using ¾ rivets (double riveted joint) the pitch according to standand before mentioned, measured on the hypothenuse, will be $2\frac{9}{16}$″ while the whole pitch at the base will be 3 ″. The *perpendicular* distance between rows, of course, will be 1¼ ″, and the lap or total width of joint can be now fixed, as the distance from rivet hole to edge of sheet will be one and one-quarter times the diameter of rivet; so the joint or lap will be $4\frac{3}{16}$ ″ wide. Now a wide joint adds strength to a boiler, and requires but very moderate caulking when closed up with a hydraulic riveter.

The great object to be reached when putting plates together is to have the shearing strength of a double row of rivets equal to the remaining section in the sheets. The tendency to rupture at the sheet is most at the section under the rivet, or from the hole to the edge of sheet. Many boiler makers fix this distance less than the diameter of rivet. This method is wrong, and is liable to split or rupture at this point, as the rivet is acting like a *blunt wedge* to force the metal apart. The excessive driving of steel drifts to "line" the holes has a very weakening effect at the point between the hole and edge of sheet, and is one of the worst and "wickedest" tools of a boiler maker's "kit". This, and the old sharp cornered caulking tool, should be abolished, as there are more ways than one to make rivet holes "line."

In fastening stays for crown sheets and large internal flues or flat surfaces, the riveting of holding lugs or crow feet, must be well distributed. The strains must not be *concentrated* on the shell of *any* boiler. Instead of lugs and crow feet, bars of T-iron should be used riveted with tolerable fine pitch to the roof of shell, so that the whole arch will receive the strain, and the shell consequently be strengthened by the T-iron. The sketch, Figs. 1 and 2, gives my idea of holding up a crown sheet, without weakening the shell.

In Fig. 1, which shows an end section, B represents the bars of T iron, the dimensions of which are $3\frac{1}{2}'' \times 3\frac{1}{2}'' \times \frac{5}{8}''$. A represents the crown bars which are made of flat bars $4\frac{1}{2}'' \times 1''$. In Fig. 2, which represents a side section B, B, represents a section of the T bars.

Now while a boiler is under a static force, constant pressure, it is all right; but, when that force is turned into a dynamic current, and that current is intermittent, with pulsations ranging in number fifty to four hundred and fifty per minute, then the conditions are vastly different. As we note these pulsations indicated on the steam gauge by a fall, *twice* in the revolutions of an engine, of from one to five pounds, we pass the poor old boiler by, without a passing glance while *it* is going through the same range of pulsations as the steam gauge pointer; the only difference being that while it does no harm to the gauge, it on the other hand has a very injurious effect on the shell. Take the case of the locomotive that exploded a few weeks ago on the Morris and Essex Railroad at Hoboken. Allowing this engine to have run five hours each day, with an average revolution of drivers of 150 per minute, this would subject the shell to 180,000 pulsations per day, and if there was bad bracing the laws relating to the fatigue of metals must certainly have asserted their rights. I believe the sheet ruptured, in the explosion mentioned here, was near the crown sheet, a little to one side of center, and received the crow feet lugs in a straight horizontal line, just below where was a double riveted side seam very stiff in itself. The action then was to buckle the sheet at each pulsation as the cylinders took steam between the side seam and crow feet; the stays and double seam below being the two fulcrums. The parting of sheet in *two* places, one very near the crow feet and one near the double seam, establishes the correctness of this theory, I believe.

Now the size of the piece of plate thrown out by the explosion was, according to the sketch in the AMERICAN MACHINIST, about 18 ″×66 ″ making an area of 1188 square inches, and allowing a pulsation of only 2 lbs. per square inch would bring on this plate an intermittent stress of 2376 lbs.—enough to make a fair start, at all events, toward the final breaking up and dissolution of the molecules of this body of metal. The Editor of the AMERICAN MACHINIST said a few weeks ago that there was a vast amount of red tape and humbug about inquiries into the cause of boiler explosions. You are right every time, Mr. Editor.

The Russian experiments in burning petroleum in locomotives have now been supplemented by similar experiments on the Lake Shore Railroad, and, it is reported, with marked success. The new fuel effects a great saving of money, besides doing away with smoke and cinders. It is difficult to exaggerate the importance of this possible extension of the consumption of petroleum. It may exercise an enormous influence upon the petroleum and coal markets.—*Boston Commercial Bulletin.*

The chief of the bureau of steam engineering recommends the appropriation of $1,165 for the erection of machinery on board of double-turreted monitors; and $25,000 for the purchase of boats for the Pensacola, Norfolk and Mare Island navy yards.

The Harrisburg car works company has increased the pay of employees in all departments ten per cent.

Letters from Practical Men.

A NOVEL FORM OF CENTERING MACHINE.

Mr. Editor:

It is well known to machinists that there is no more convenient tool about a shop than a good centering machine for small work. The most common form in use, at the present time, is the one with a three-jawed scroll chuck, and spindle with a lateral motion. The objection to this is that they soon wear so that they won't center true, and it is almost impossible to keep oil on the center tool where it is needed most while cutting. Another objection is that the centers made by it are seldom, if ever, in line. Some shops do their centering with speed lathes. These get the centers in line, but they are unhandy, because one hand of the operator must be used to hold the work from turning, and the other to do the feeding. If he wishes to use oil he must quit feeding while he supplies the oil, and by the time he sets down the can and starts feeding, the oil has all been thrown off the tool by centrifugal force.

All these objections to the machines now in use, have suggested to me the one which is represented by the accompanying cut, and I hope there is enough merit about it to pay for the reading of this article. The body of this is a hollow column, with a flat face on the front side, and has a semi-circular base. The bottom center stock slides up and down on the body, and is counter-balanced. It is free from the face of the body, and fits in grooves on each side so that the chips cannot clog it and prevent a free movement. It is tightened in its place by an eccentric tightener. On top of it is an adjustable piece, having a conical-shaped recess for receiving one end of the piece being centered. This swings around from its position by unscrewing a thumb-screw, thus allowing a center to be placed in a taper socket in the main part of the stock.

The chuck is of the V form, as that will center more different forms of work than a three-jawed chuck. The jaws are operated by a screw having a left hand thread on one end and a right on the other, and is turned by a crank. The spindle moves up and down in its place, and is held up in its normal position by a flat spring attached to a collar at the top, and extending back in a curve that prevents side pressure on the spindle. To this spring is a rod attached, which passes down the inside of the column to a treadle shown at the base; thus leaving the operator's hands free to handle his work, while he presses down the spindle with his foot. The pulley on the spindle should have journals of its own on each end, and the hole in it should be 1-16″ larger than the spindle, so that it will not touch it. The pulley will drive the spindle by a pin working in a slot in the spindle. The object of this is to prevent the tension of the belt from wearing the spindle out of line. The spindle will be run by a quarter-turn belt from the large pulley shown in the cut. This machine requires no hangers and no bench to put it on, and as Chordal says, "No one to love, none to caress." The main advantage of this machine would be, that when oil is put on the cutter it would *stay* right where it is needed most.

Now, will some one who has influence get at it, and do the missionary work of convincing some manufacturer of tools that this is a good thing, and it will save us poor fellows, who have so much centering to do, a great deal of swearing, etc.

Respectfully yours,

A. RANDOLPH.

HAMILTON, Ohio, Nov. 23, '79.

Editor American Machinist:

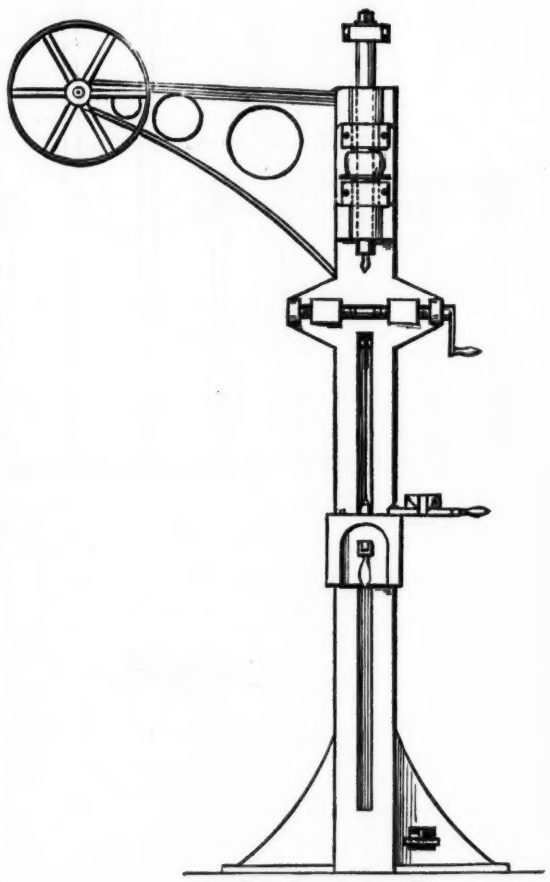
I read in your issue of November 1st an article on Indicator motion, used on the Brown engine, the same being an extract from "Chordal's Letters." I first used the lazy-tongs for the purpose of getting Indicator motion, in the Spring of 1873. I was then an employee of the Corliss Steam Engine Co., Providence. I had a job to indicate the engine of a rolling mill in Readville, Mass. It was an upright engine, and so surrounded that the ordinary means of getting the indicator motion could not be resorted to. I gave the matter some thought, and at last brought the lazy-tongs arrangement to my aid. It was the first time, to my knowledge, that it had ever been used for this purpose. In the Fall of 1874 I made a modification of the arrangement, which was applicable to all forms of mill engines, exactly as your correspondent describes.

The lever arms were made of cherry wood, carefully laid off; the pivots with which the affair was jointed were made of brass tubing, riveted over a large washer; that, if any heat were generated by friction, it would be conveyed away by the circulation of air through the hollow pivots, otherwise the non-conductibility of the wood might cause an accumulation of heat. I have since made a modification of the same apparatus, applicable to engines of steam launches; it is always easy in its application and reliable in its motions.

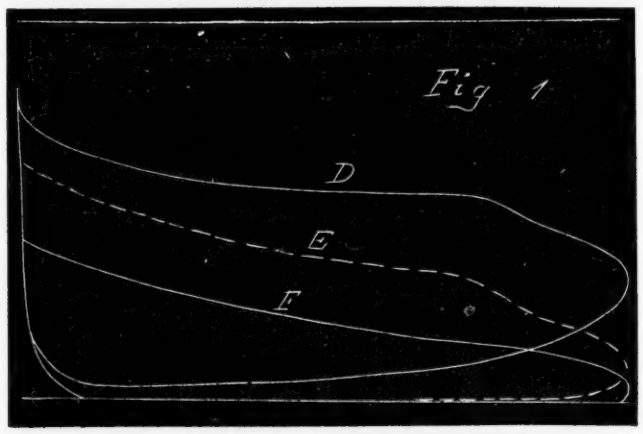
Yours respectfully,

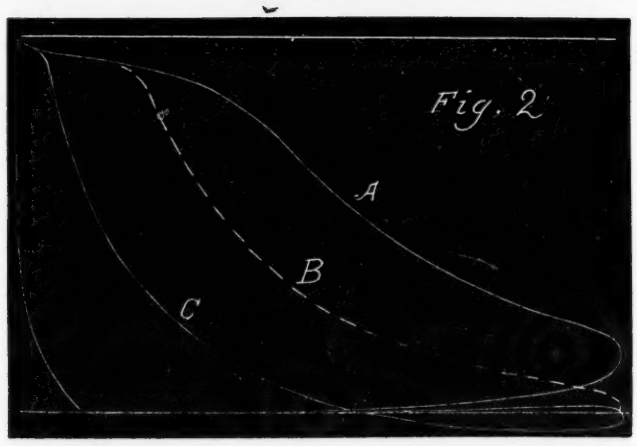
NATH'L G. HERRESHOFF,

Herreshoff Manuf. Co., Bristol, R. I.



NEW CENTERING DEVICE.





Talks.—Fuel Saving Governors.

BY WM. LEE CHURCH, C. E.

It occurs to me that I put it a little too strong, the other day, when I said that I discovered *the* reason why B.'s governor saved fuel. It would be better to call it *a* reason, and, perhaps, it is only an inferential one at that. Very likely there are other and better reasons for accounting for the same thing, but, personally, I have had but comparatively little to do with throttling governors, and so, probably, never ran across them. Then, too, I don't want to cast any reflection on governor builders in general, so it is only fair to say that the scene of B.'s exploits was laid in a part of the country where the question of governing has not got down to a very fine point, and the engines he worked on were throttling engines, and a rather venerable lot at that. However, as I have met with similar cases right around in this high-toned locality, it isn't amiss to talk it up a little for what it is worth.

The engine I was at work on when the idea occurred to me, was running as regular as a clock, although the load was varying momentarily to a moderate degree, just enough to keep the governor on a nervous dance to keep up with it. For instance, the load drops a little all at once, and the governor makes a grab for the steam, but, getting under too much headway, it overshoots the mark, and shuts off too much. So the next time around to even up, it lets on too much, and so on *ad infinitum*. Now it takes an over-sensitive governor to do this, and yet hold the speed steady; but we have all seen plenty of such, on an anxious teeter all the time, and dodging around like a man trying to balance a straw on his nose. Now the *average* of the thing is all right as to power, the engine plods along steadily enough, and the hands at the spinning-frames don't grumble about the speed. But how about the economy in this system of general average? Fig. 1 gives us about the idea. We will suppose the cards to be continually fluctuating between the limits of D and F, owing to the "hunting" of the governor. Many of you have met instances where a continuous diagram for 50 revolutions would pretty much cover the space between D and F with lines, showing a tendency, however, to accumulate in the vicinity of those limits. The average load represented by the assortment we find to be the dotted card E which is the intermediate in value between D. and F. as to *m. e. p.* Now, as far as power is concerned, it would make no difference whether we got our power out of two alternating cards, D and F, or the constant card E. Now compute the cards for water. In round numbers, E shows 31 lbs., which may be considered as the fair representative of the power developed. But now take the actual cards and D is found to show 42 lbs., and F 39 lbs.: average, 40½ lbs. So far as the cards show, then, we may expect to use up about 30 per cent. more steam off from our hunting governor than from one that will stay close to its work. In short, the average of the *economy* of two loads is not thermally proportional to the average of the loads themselves, and this is probably true whether the variation is actually in the load itself, or is only an apparent variation due to the governor. This corresponds to the practical results embodied in an "economy diagram" presented some months ago. Fig. 2 represents the same action in an automatic cut-off, $\frac{24+33}{2}=28\frac{1}{2}$ lbs. being the actual average, against 20 lbs. required by the load. Both of these Figs. probably are extreme cases, but that fact does not affect the conclusion.

The reasons for the above are fairly obvious. In either figure the too full supply, as A and D, is followed by an excessive terminal. The point of release (of which more hereafter) is usually about right for a more moderate load, and hence does not let go early enough to get rid of the large load of steam, and back pressure results, for one thing. This is more apt to be the case in throttling engines, with their tortuous ports, than in the more modern and freer-ported automatics. In Fig. 1 the sudden impulse on the engine, from the excessive admission, increases its speed for the instant, and the governor makes a plunge, showing the concave steam line. The plunge is usually followed by a partial reaction before the valve closes, with the result, as stated, of cutting down the mean effective and elevating the terminal. In an automatic, Fig. 2, the long follow frequently exhibits a wire drawing of the steam, which is, however, of doubtful harm.

On the other hand, the over-closing of the governor reduces the *m. e. p.* much faster than it reduces the terminal (Fig. 1), and in Fig. 2 the early cut compels expansion below atmosphere, and the even more serious losses from excessive internal condensation. The writer has often adjusted the governor of an automatic engine so closely to isochronism, that the balls would vibrate over a range as great as that shown in Fig. 2, with pendulum-like regularity. The effect on the coal pile was fully as disastrous as indicated, while the effect on the speed was imperceptible.

Moral: proportion your load and engine to their most economical relations, and get a governor that will hold it there.

Turbine Water Wheels.

BY SAMUEL S. WEBBER, C. E.

No. III.

Before beginning our test, we will suppose that the wheel to be tested is 25 inch. diam.; head of water, 31 ft.; length of weir, 9 ft., with two end contractions; circumference of circle, of which brake arm is the radius, 33 ft.; leverage of scale beam, 2 to 1. The builder of the wheel expects it to develop 50 H. P., and discharge about 1000 cubic feet per minute, which is not an extravagant claim, if the wheel is what he says it is—"The *best* and *most economical* wheel *ever* made." We now start up, and, after running a few moments, to make sure everything is secure, a weight of 72 pounds is put into the scale pan, and the brake tightened up until the friction is sufficient to lift the weight and bring the scale beam level. Now, at a bell signal, the revolution counter is thrown into gear and the count taken for two or more consecutive minutes, the weir reading, by hook gauge, being taken by an

assistant at the same time. The signal is now given for "time," and we find the data as follows: Weight, 72 lbs.; head on wheel, 31 ft.; revolutions per minute, 300; head flowing over weir, .664 ft. Now, the first calculation is to get the power actually developed by the wheel, and is as follows:

$$\left(\begin{matrix}\text{Weight.}\\ 72\text{ lbs.}\end{matrix}\right)\times\left(\begin{matrix}\text{Leverage.}\\ 2\end{matrix}\right)\times\left(\begin{matrix}\text{Revolutions.}\\ 300\end{matrix}\right)\times\left(\begin{matrix}\text{Cir. of brake circle.}\\ 33\text{ feet.}\end{matrix}\right)=1{,}425{,}600\text{ foot lbs.}$$

Dividing by 33,000=43.2 horse power.

The calculation for the water flowing through the wheel is by the formula thus: $3.33\,(L-0.1nh)h^{\frac{3}{2}}$, or, substituting our data,

Length of Weir. Head on Weir. Head on Weir.

we have $3.33\times(9-.2\text{ of }.664)\sqrt[2]{.664^3}$ or $3.33\times8.867\times.541=15.97416651$ cubic feet per second, or, × by 60=958,559 cubic feet per minute. This, multiplied by 62.3 the weight of one cubic foot of water=5971.13727 × by 31, number of ft. head=185105.25537 foot pounds, or, ÷ 33000=56.09 H. P., the value of the water used. Then 43.2÷ 56.09=.7648, or a little more than 76 per cent., a result not up to the builder's expectation. So we put on four pounds more weight, and the increased friction required to make the brake lift reduces the speed to 295 revolutions per minute, and the weir gauge shows a slight increase in the water used, or .668 feet head. These data will show about two per cent. gain, the power of the wheel being 44.84 H. P. and the water being about 57 H. P., or a trifle over 78 per cent.; 80 pounds on scale will give 288 revolutions, or 46 H. P. The weir reads .672, or about 57.5 H. P., showing a further gain in percentage, or 80 per cent. This seems to be the maximum, as on trying a greater weight we find the speed reduced below that required to give the best result; and so the wheel, at 288 revolutions per minute, giving 46 H. P., has shown a duty of 80 per cent., or fairly up to the rating of a "good" wheel. We now go on to ⅞, ¾, and ½ gate; that is, using these proportions of water, taking the full gate discharge as 1. The result will, as a general thing, show a falling in the percentage of power in about the following scale: ⅞ gate, 77 per cent.; ¾ gate, 73 per cent.; ½ gate, 68 per cent.; or an average of about .75. These figures represent the performance of the average "good" wheel, and any below these figures would class the wheel as second rate, while results in excess of an average of 75 per cent. would entitle a wheel to more than a classification of "good." The "best" would have to show a duty of 90 per cent. full gate, and there have been well proved instances where this remarkable result has been attained. I say remarkable, as the water, in leaving the wheel would have a velocity representing about four per cent.—at least nearly that would be necessary in order to get the water out of the wheel; so with 90 per cent. duty +4 per cent. represented by the discharging water=96 per cent., leaving only six per cent. for loss in the passage of the water through the wheel and for the friction of the wheel on its step and bearings, this is about as near to perfection as we can hope to attain, and as yet only a few wheels have been built giving such results. The most notable one was the Atlantic "Boyden," which gave a percentage (with a "diffuser" to assist the passage of discharging water) of 92 per cent. at full gate. This wheel was, of course, very expensive, being made with polished brass bucket and guides and was 104 inches in diameter. With the diffuser off, the percentage fell to .89, while the part gate tests, in both instances, fell in percentage below that of a "Risdon" wheel, whose full gate was lower by three per cent. This latter wheel was of ordinary construction, with iron buckets and guides. The Boyden wheel was tested, I believe, by Mr. Boyden himself, and the Risdon by Jas. Emerson. The best result I have obtained with the Risdon was .8766 at full gate; at ⅞ gate, .8633; at ¾ gate, .8252; at ½ gate, .7535; an average of .828. The conditions attending this test were not as desirable in some points as they might have been, and perhaps the Risdon and other wheels, tested at the same time, might have shown a slight gain in percentage had the flume and penstock been more securely stayed, braced and made of heavier material. As it was, the results were fully equal to what might be expected in ordinary mill practice with the ordinary setting, thus making the tests all the more valuable to practical men on that account. In making "part gate" tests, it should be understood that many so-called part gates are not properly so when the quantity of water discharged is taken as the measure (as it *always should be*), for I know of wheels that will discharge ⅘ as much water with the gate three-fourths opened as they do when the gate is fully open, or open beyond the point necessary to furnish the wheel all the water that can pass through it. This measure should be the full gate in a strict sense of the term and .75, .50, and such proportions of the full discharge should be taken to express part gates, instead of inches in area of gate opening. There has been a great deal of misunderstanding on these points, and so I desire to give the matter special mention.

I have endeavored to give a comprehensive illustration of the way of making a test, and now I will take up the construction of wheels as found in the market, going into the details of the various types and classes of wheels to some extent. But in mentioning names of builders, I wish it understood that I only do so to designate more clearly the distinctive peculiarities of such wheels, and not because I have any preference for those wheels myself.

Advantages of High-Speed Engines.

BY CHARLES T. PORTER.

No. 9.

The reader who has thoughtfully read the later articles of this series should, I fancy, have become so well acquainted with the subject of them, which, although it has only lately attracted the attention of engineers, is, in truth, a very simple and elementary matter, that what I have now to say will be received by him as a matter of course. We have to inquire: How can the inertia of the reciprocating parts of an engine be turned to the best account? How can it be made to serve the most useful purpose?

The steam engines which only at the present day we consider entitled to any regard for stationary uses, are those which work steam expansively, and where the resistance is variable, vary the force to correspond by changing automatically the grade of expansion.

In such engines the steam is cut-off usually at or before the first quarter of the stroke. Up to the point of cut-off, nearly the full boiler pressure is exerted on the piston. From this point the pressure falls very rapidly, and during the last quarter of the stroke is trifling, and often at the end has, in non-condensing engines, fallen quite to, or even below, the atmosphere.

Now if the reciprocating parts of the engine were without weight, the same enormous difference would exist between the forces exerted on the crank in its alternate quadrants, and when this would come to be added to the variation of rotative effect, arising from the continually changing angular position of the crank, it would aggravate it in the extremest manner possible, so that nothing can be imagined more excessively intermittent than the driving would be. Out of this it would be demanded from engineers to get a steady motion. The fly-wheel furnishes the only resource, and, however large or heavy, it could only approximately meet the requirement; the great amount of force it would have alternately to absorb and to exert involving precisely corresponding acceleration and retardations of its motion. But fortunately the reciprocating parts of an engine have weight. All the time while engineers knew nothing about it, right before their eyes the alternate acceleration and retardation of these parts have been going on, in every stroke of every steam engine that ever ran, according to the law which has been explained in these papers; correcting in a greater or lesser degree these extreme inequalities of pressure, and relieving the fly-wheel of the severest part of its duty.

Take, for illustration, an engine 36 inches diameter of cylinder, by 5 feet stroke, making 50 revolutions per minute, and the reciprocating parts of which weigh 3,000 lbs., with connecting rod 15 feet long. What are the accelerating and retarding forces required, on each dead-point. to impart and arrest their motion?

$R^2=2500$; $L=2.5$; and $2500\times2.5\times.000341=2.13125$

Not futher repeating computations already given, the accelerating and retarding forces are: On the back center, 7,459 lbs., and on the forward center, 5,328 lbs. The area of a 36″ cylinder is 1,018 square inches. So the correction of inequalities of pressure amounts to 12.56 lbs. on each square inch of piston area. Not very much, it is true, but sufficient to make a very great difference in the approximation to steadiness in the running of the engine.

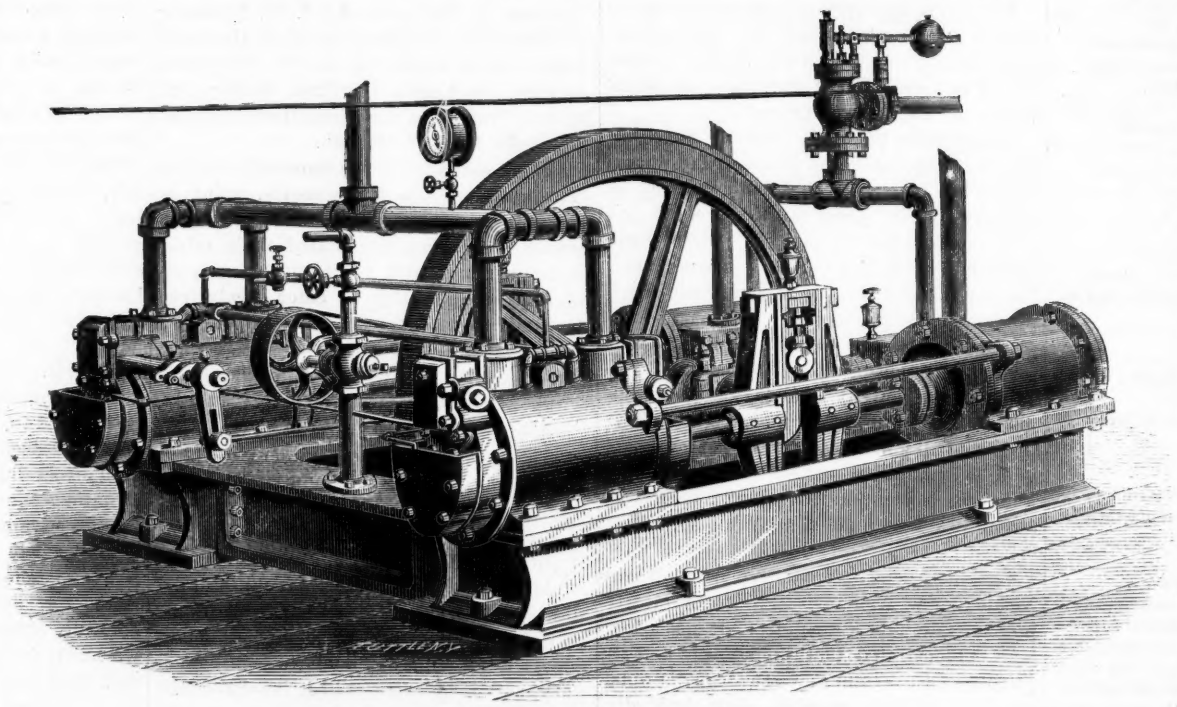
How easy it is to do incomparably better than this, my readers have doubtless already anticipated. Nevertheless, I will ask them to consider it with me in the next paper.

"The man who knows a thing, and can tell it in the fewest words, iz the hardest kin of a man to beat in a kross examinashun."

Clayton's Air Compressor.

We illustrate this week an air compressor manufactured by the Clayton Steam Pump Works, Brooklyn, N. Y. It will be observed that the air-compressing cylinder and steam cylinder are both fastened securely to the same bed plate, and that the piston-rods of each are connected by means of a slide yoke, which gives motion to the crank shaft, by means of the crank pin boxes which slide in the yoke.

The air is cooled on the "dry system" by means of a water-jacket that encircles the cylinder. This water-jacket is arranged in such a manner that, as the cold water enters at the extreme end of the cylinder, it meets with the greatest amount of heat where the greatest pressure occurs. It will be noticed that there is a pipe that runs from the bottom of the air reservoir to the heads on the end of the air cylinder; on the vertical portion of this pipe there is a plug cock, having a chamber in the plug extending on to the center, forming a pocket. On the stem of this plug a pulley is attached which is driven from the main shaft. By means of this device a certain amount of oil is fed automatically into each end of the air cylinder, which lubricates the cylinder, and fills up all the waste space that may exist between the piston and the discharge valve. There is a feature connected with the opening of the air-discharge valves that is entirely different from any thing that has been done in this direction before, and is claimed by this company to add greatly to the economy and efficiency of this compressor. An eccentric set at a certain position in relation to the crank, and connected by suitable mechanism to the discharge valves, trips them when the desired pressure is reached in the cylinder, thus avoiding the necessity of pressing the air above the pressure called for, as is done in other machines. An attachment placed upon the main steam pipe of the steam cylinder, and connected to the air reservoir, is designed to regulate the amount of air furnished by the machine. It is virtually an air governor operating upon the stop valve of the engine; so that if the pressure of air in the reservoir rises, the device shuts the valve, and should the pressure of air fall, it closes it.



CLAYTON'S IMPROVED DUPLEX AIR COMPRESSOR.

In Russia, up to the present time, there are 205 works engaged in the manufacture of agricultural machinery. Of this number 80 use steam power for driving their lathes, 7 water power, and 90 horse power. The remainder use only hand power. The best threshing machines, copied generally from foreign models, are manufactured in the Riazansky Government. They cost 90 to 120 roubles, and are sold in notable quantities in the middle parts of that district. In order to stimulate this industry the railway tariff must be lowered, as at present, on many railways, the tax for the conveyance of agricultural machines is about 10 per cent. of the cost of the machines.

The machinery in the new grain elevator at Canandaigua, N. Y., is to be driven by gas.

Is is reported that rich beds of emery have been discovered in Westchester county, N. Y., and that a stock company, composed of Major Rachau, Dr. Wm. H. B. Post of No. 200 W. 52d St., Dr. Allen McL. Hamilton of No. 2 E. 32d St., this city, and others, has been formed to work them.

AMERICAN MACHINIST

PUBLISHED WEEKLY

BY

American Machinist Publishing Co.

HORACE B. MILLER, Prest.
LYCURGUS B. MOORE, Treas.
JACKSON BAILEY, Vice-Prest.
DAVIS STRONG, Sec'y.

96 Fulton Street, New York.

JACKSON BAILEY, Editor. HORACE B. MILLER, Business Manager.

LEWIS F. LYNE, Mechanical Engineer.

Edition, 9,500 Copies.

The American News Company.
Publishers' Agents, New York.

The International News Company,
(Formerly the Willmer & Rogers News Co.)
11 BOUVERIE STREET, (Fleet St.) LONDON, ENG.
Will receive subscriptions for the AMERICAN MACHINIST at 17 shillings per annum, postage prepaid.

DEALERS SUPPLIED BY
The New York News Company, New York.
The National News Company, New York.
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The Central News Company, Philadelphia, Pa.
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The Albany News Company, Albany, N. Y.
The Toronto News Co., Toronto, Ontario, Canada.
The Toronto News Co., Clifton Branch, Clifton, Ontario, Canada.

SUBSCRIPTION.

$3.00 a year, in advance, postage prepaid in the United States and Canada.
$4.00 to Foreign Countries, postage prepaid.

ADVERTISING.

Outside page, 45c. per line, each insertion.
Inside pages, 25c. per line, (12 lines one inch.)
Business Specials, 40c. a line.

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☞ *We are not engaged in procuring patent rights, or in selling machinery; nor have we any pet scheme to advance, or hobby to ride.*

☞ *We invite correspondence from practical machinists, engineers, inventors, draughtsmen, and all those specially interested in the occupations we represent, on subjects pertaining to machinery.*

☞ Subscribers who fail to receive their paper promptly will please notify us at once.

☞ Entered at the Post Office at New York, N. Y., as second class mail matter.

NEW YORK, DECEMBER 20, 1879.

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Chordal, this week, discusses the development of the steam engine indicator from the time of James Watt to the latest improvements. It will be readily understood by aid of the numerous illustrations, all of which we have made to accompany Chordal's descriptions. Considering the growing importance with which the indicator is regarded, this article will be widely read.

Government Engineering.

During the session of Congress, various appropriations for engineering purposes are discussed, and near the time for adjourning some of them are passed through in the greatest haste, without much regard for their real merits. The engineering works of the Government are both civil, mechanical, and military.

The largest civil engineering work now in progress, is the improvement of the Mississippi river. The Eads' Jetties bid fair to open that greatest American water course to the free navigation of large vessels, thereby aiding most substantially the commerce and productive industries of the Western States. Whether this great enterprise costs the country more than the benefits to be derived from its successful completion are worth, is a question that has been quite sharply discussed, but the popular verdict seems to be strongly in favor of pushing forward the work, now far advanced. Numerous schemes for opening up small rivers and creeks, come before Congress about every session, some of which are worked through carefully.

The bill to appropriate a sum of money to remove "the obstruction to navigation" from the Kiskemenetas trout stream was defeated last year, but it may come up again with other engineering projects.

Considerable money is annually wasted in our navy department, in building and repairing useless vessels. The visitor to any of our navy yards cannot fail to be convinced of a needless drain upon the public purse continually going on in these establishments. The building of vessels is begun, and when fairly under way, stopped. These non-completed ships of war then figure in petitions for further appropriations. Occasionally an exhibition of activity is made, and the building process continued for a brief time. While this foot-ball game is being carried on, years glide by, and the incompleted hulls rot down upon the stocks, or the style of vessel becomes obsolete, and of no value for naval combat.

The inefficiency of our expensive Naval Academy at Annapolis has been clearly pointed out in these columns. It has often been demonstrated that the building and repairing of Government vessels can be done not only at less expense, but decidedly better by private establishments than it is done at any of our navy yards.

There is something chronically wrong about Government engineering as ordinarily practiced. By a comparison of the cost of making rifles and bayonets at the Springfield Armory, with the cost of doing the same by contract with responsible private parties it is conclusively shown that the Government is paying three to four times what it could get its work done for. There is nothing gratifying in this, nor commendatory of Government machine shops.

The mistakes and extravagances of Government engineering are traceable in the main to faulty legislative action. In view of the blunders made therein, it would seem that the presence of a few active engineers, civil and mechanical, in our National Legislature, would prove decidedly beneficial to the country.

What Apprentices should Read and Study.

The inquiry frequently reaches us as to what books an apprentice should read, study and keep at hand for reference. One of the first books an apprentice should become familiar wich is the arithmetic. Unless he becomes proficient in arithmetic, he will find almost insurmountable obstacles to his advancement in mechanics. He needs to go farther than simple fractions, and to make a thorough acquaintance with decimals, percentage, square and cube roots and mensuration. The next step is to enter algebra and follow it persistently week after week, and month after month, not throwing it aside because he may not be able to see its direct application in the shop where he is learning his trade. Some of the best working mechanics experience an annoying lameness in prosecuting their researches after correct technical information by knowing nothing about algebra. They limp along as fast as possible, with their limited acquirements; but when perusing the works of some of the best authors on mechanical subjects get completely floundered by reason of not understanding algebra. Natural philosophy may next be taken up and pursued with interest. The study of geometry might profitably be undertaken with it. By aid of mathematics the truths of natural science may be made clear by demonstration, and the *ipse dixit* of dogmatical writers criticised before being accepted as proven. An apprentice must acquire the constant habit of *thinking for himself*, and not relying upon whatever statement he sees in a book on mechanics. If he is well grounded in mathematics, this will come easy, and he will be able to weigh the utterances of those who are taken as authorities upon phenomena goverened by the laws of physics.

Among the many works on mechanics that an apprentice (a machinist) can read with positive benefit, we may mention Workshop Manipulation by J. Richards; Experimental Mechanics by Prof. Ball; Elements of Mechanics by J. W. Nystrom; The Mechanics Tool Book by W. B. Harrison; Steam Engineering by J. W. Nystrom; Applied Mechanics by Prof. Willis; and Modern Practice of American Machinists and Engineers, by E. P. Watson.

Again, we say, let the apprentice take a thorough course in mathematics, going as far as his time and means will permit, especially becoming acquainted with arithmetic, algebra, and geometry, before considering himself ready to enter deeply into the study of mechanics.

The weakest spot in many machine shops is the tool department. Unless a well-devised, and persistently followed system prevails in the care and distribution of working tools, a most serious loss will be going on. It only needs an inspection of the tool-room of a shop to acquire a pretty accurate idea of the character of work turned out in the establishment. Good tools should be kept clean when laid away, and if edge tools, well sharpened. With tools in bad condition it is extremely difficult to secure good work, and if by extra skill it is secured the expense of time and labor more than counterbalances the value of the result.

The next issue of the AMERICAN MACHINIST completes the Second Volume, and the one following (dated January 3, 1880) begins Volume III. Although we entered upon our third year Nov. 15, our volumes will hereafter begin and end with the calendar year. We shall begin the third volume with a series of illustrated articles on mechanical drawing by a thoroughly qualified and experienced draughtsman, who will give some useful instruction in this art without calling to aid the higher mathematics. At the same time, we shall begin the publication of a series of practical working drawings of machinery, by Mr. Wm. H. Hoffman, which have been in preparation for several weeks.

Equity in Discharging Workmen.

Several instances of abrupt and summary discharge of workmen have recently come to our knowledge, which go to prove that it is a growing practice to obtain first-class talent and valuable services at a low rate, on strong promises of a greater remuneration in the future, and a permanent situation. We will give two cases of recent occurrence; from these our readers will judge if such procedure is equitable and right. A, in the South, gets a large order and requires skilled workmen. To obtain these he advertises in some of the widely circulated northern papers, and receives numerous answers. He selects what he considers the most eligible. He requires references and amount of wages wanted. He gets satisfactory references, assurance of competency, and the figures for remuneration wanted. His final terms are that B shall come at low pay, with a prospect of better; that A will pay all traveling expenses; that the situation will be permanent, and if he has a family he can bring them and settle, as A will always need such services.

Traveling expenses paid, increased remuneration promised, permanency of situation assured, and B accepts. Family moved, worked commenced. B is faithful, sober, expert; he gives satisfaction. The large order is filled, and B is told that there is no longer need of his services. B growls about injustice, disappointment and expense of getting back to his former field of labor. Finally a compromise, if it can be so called, is patched up, and B's personal traveling expenses, not those of his family, are given him, with an hypocritical apology—something about being sorry to part with him. B does not get over change of climate and loss of money for several months.

Again another; A, in a northern city, engages a first-class man on Saturday morning to go to work on Monday morning, if he will commence at a low rate of wages, and stay permanently with him. Plenty of good work, pay regular every week, business to be extended; B accepts. The other man C, whose place B is to fill, is discharged on Saturday afternoon. B proves very expert, very faithful; uses neither liquor nor tobacco. During a temporary absence, permission having been fully given, B returns to find his placefilled by one at still lower wages than his. All that B can do is to pick up his tools, feeling *sold*, and try again. Put the boot on the other leg. A is pressed with work, and depends greatly on B's expertness and promptness. Suddenly B tells A he can do much better, and leaves without a day's notice. O, what high talk about injustice and not being used right, and perhaps abuse follows if B is fool enough to stand it.

Employers will never allow themselves to be dictated to, when or how they shall procure and discharge workmen, but as a matter of correct business and equity, misrepresentations should not be made to gain a temporary advantage, and both employer and employee are entitled to a reasonable notice (a week is short enough) before a change is made. If agreements are in writing and carefully drawn up the law can protect workmen in their rights; but what money and time has an industrious workman to spend on law, and therefore the greater sin is at the employer's door?

The employees of the Whittier Machine Co., Boston, Mass., were each made the recipient of a nice turkey the 26th ult. from their worthy employer, Mr. Charles Whittier, the President of the Company, it being his fiftieth birthday. The latter fact being made known to them early in the day, they were enabled to render congratulations in the form of two very fine bouquets, which were presented with the kindest of regards and well-wishes to their employer. Such expressions of mutual feeling cannot but be gratifying to both employer and employed. Would that more like sympathies might be recorded.

We esteem it a pleasure to be able to give any of our readers answers to particular questions by mail or in print if suitable for our regular department of Questions and Answers. To give clear and correct answers to some inquiries has often necessitated considerable research, but the time and effort have always been willingly put forth. Some questions we are able to answer immediately, while others may take several weeks. None of our readers need think their questions are thrown aside or forgotten if they are not answered at once.

Watt made his first model of the condensing steam engine out of an old anatomist's syringe, used to inject the arteries previous to dissection. Guilford worked his first

problem in mathematics when a cobbler's apprentice, upon small scraps of leather, which he beat smooth for the purpose, while Rittenhouse, the astronomer, first calculated eclipses on his plow-handle.

Business Specials.

Forty cents a line for each insertion under this head.

Manual of Power for Machines, Shafts, and Belts, with the History of Cotton Manufacture in the United States, by Samuel Webber, C. E., copyrighted 1879. Only work of the kind extant; 240 pages. Price $3. Address, D. Appleton & Co, New York, or the author, Manchester, N. H.

The Huntoon Steam Governor Co., of Lawrence, Mass., warrant a direct saving in steam of from 10 to 20 per cent. over any other Governor known; while for quick and accurate regulation, great durability and lasting economy in use, they guarantee results never before attained by any other. See advertisement.

Lathe Attachments for Milling Plane and Irregular Forms; Taps and Reamers fluted and Gears cut without removing from the lathe centers. For extended description, see AMERICAN MACHINIST, Sept. 13 and 20 issues. Send for circular to Wm. Main, Piermont, N. Y.

For sale low, 6 and 20-horse Portable Engines. 7 x 14, 7 x 20, and 16 x 48 inch. Horizontal Engines. 3 x 13½, 3½ x 14, and 4 x 14 foot Tubular Boilers. All guaranteed to be in a No. 1 condition. Other sizes on hand. Belcher & Bagnall, 40 Cortlandt St., New York.

Tool Chests with best tools, scroll saws, wood and designs. Amateurs' and Machinists' Tools. Send for Catalogue. Tallman & McFadden, Philadelphia.

Steel Stamping Figures and Dies.—1-16" to 1-8" Figures, per set, $1.00; 1-8" Letters, $3.00. American Tool Co., Cleveland, O.

Questions and Answers.

Under this head we propose to answer questions sent us, pertaining to our specialty, correctly and according to common sense methods.

(1) G. H. B., Jersey City, N. J., asks: 1. Would there be any appreciable difference in the temperature of a steam engine cylinder where the steam is cut off early in the stroke and allowed to expand down to atmosphere? *A.*—Yes, there would. An indicator card would show the pressure in different parts of the stroke, and the temperature would correspond to them. 2. Is there any noticeable difference in the temperature of the metal of a cylinder when unjacketed? *A.*—There is more heat radiated than if jacketed, but the condition will be about the same as in the first question. 3. Have heard it stated by practical men, that the differences of temperature at the beginning and end of the stroke would vary the diameter of the cylinder, sufficient to require a piston, capable of adjusting itself to the differences of diameter. *A.*—Most certainly, we have always found it so in practice; any attempt to make a solid piston work steam or air-tight, under the above conditions, has always resulted in failure.

(2) G. W. G., Cincinnati, Ohio, wishes to know the name of some good book on the Stationary Engine, also some good book on mechanical movements and appliances. *A.*—Arthur Rigg on the Stationary Engine is the latest and most complete. Willis' Principles of Mechanism is considered a good work on mechanical movements.

(3) D. P. K., Plainfield, N. J., asks in which state a boiler weighs the most—when cold, or when steamed up. *A*—When cold. It weighs as much less when steamed up as the amount of air blown off when the safety valve is lifted. 2. Where can I get a machinists' guide, the very best? *A.*—Holtzapffel on Turning and Mechanical Manipulation, by Chas. Holtzapffel. 3 vols., 8vo. London, 1866. Price $25. Or as a cheap, yet good practical work for the machinist, we recommend Harrison's Tool Book. 12mo. Price $1.50.

(4) L. M. G., Marrietta, Pa., writes: Do you know of any guide books on moulding? *A.*—Larkin's Brass and Iron Founders' Guide. 1 vol., 12mo. Price $2.25. Also, Casting and Founding, by R. E. Spretson. 8vo. Price $7.00.

(5) W. H. S., Cheboygan, Mich., writes: What is the difference in steam pressure in a 2" steam pipe and the boiler that supplies it? *A.*—There ought not to be any if the pipe is well protected with lagging. 2. What do you think of the coil boiler? Would ordinary pipe answer for a small one of 2 or 3 horse power? *A.*—Coil boilers are as yet only in the experimental stage; we know but little of them; the strength would depend on the diameter of the pipe. 3. Had charge of an engine, the boiler began to foam furiously, so that the water ran down the chimney from the exhaust. I shut off the pump and blew off the water from 3 gauges to 2. Priming stopped. Was it safe to do so? *A.*—We should say yes, but a great deal depends on the kind of boiler. Some boilers require the water to be watched a great deal closer than others.

(6) F. A. R., San Francisco, Cal., writes: Wishes to convey live steam 500 feet from boiler to factory; 5 H. P. would furnish steam enough. *A.*—A wrought iron pipe one inch in diameter inside, would be amply large enough. It should be lagged or covered with any good non-conducting material, such as felting and canvas, and incased in a wooden box. There should be no difficulty in conveying steam the above distance with very little loss of pressure.

MANUFACTURES.

D. Saunders' Sons, Yonkers, N. Y., have just sent two six-inch pipe threading machines to Chester Tube and Iron Co., Chester, Pa.; also, one (4 inch) to Robt. Wetherell & Co., of the same place. They are shipping to various parts of the United States, also to Canada.

The Chicago & Alton road proposes to build a new car shop at Bloomington, Ill., and will do all its own work hereafter; the work of outside manufacturers, in many instances, it is said, proving dissatisfactory.

The World's Light Manufacturing Company of Chicago, has organized with a capital of $1,000,000. The object is the manufacture and sale of machines and fixtures for illuminating purposes.

About January 1st the Worcester Machine Screw Company, of Worcester, will remove their machinery and fixtures from their present location to Beacon Street, where they have erected a building 150x36 feet and two stories high, thereby more than doubling their present capacity. The power for the new works will be furnished by a 35 horse power Corliss engine, and all the arrangements in progress are of the most approved character and well adapted for the business.

C. & J. A. Colvin, of Worcester, Mass., are to build a new foundry. The main building will be 100 by 50 feet, and the wing 50 by 30 feet.

George H. Fuller, manufacturer of materials for jewelers, at Pawtucket, Rhode Island, is to build a large establishment in the spring. The building will be three stories, and 35 feet wide and 100 feet long. The lower story will be of brick and the upper ones wood.

It is reported that J. H. Bramwell, of Quinnimont, West Va., and Eastern partners have been buying up the Ironton, Ohio, Iron and Steel Company bonds, and have purchased a controlling interest, about $150,000, at 15 cents on the dollar. It is said that they will force the sale of the works immediately, and put them into operation as soon as practicable. In addition, they have purchased of the Lawrence Furnace Company 1,000 acres of ore lands. The Pomeroy Rolling Mills have been bought by Ironton parties.

I. H. Redding and George H. Searle have leased the Bramanville Cotton Mill at Millbury, Mass., which have been idle for several years, and are to start up immediately in the manufacture of yarn. The mill contains 4,000 spindles, and formerly run on print goods. The establishment will be conducted under the firm name of the Bramanville Yarn Manufacturing Company.

The Arlington Mills of Lawrence, Mass., have just effected the purchase of some six and a half acres of land lying on the Spicket River between their mill and Ingalls's hat factory, with a view to extending their manufacturing operations.

Mr. Joseph Wharton, proprietor of the Nickel Works, is erecting a large building on Tenth street, Camden, N. J., adjoining his works. Nearly all the nickel used in the United States is the product of this establishment.

The Clark Terra Cotta and Brick Company is the name of a new concern that has purchased 15 acres of clay land near Glen's Falls, N. Y., and the Horace Howard marl bed, Queensbury. T. M. Clark, inventor of the process to be used, is superintendent of the works. This enterprise will employ 100 men. —*Troy Evening Standard.*

Messrs. Cofrode & Saylor are building a large extension to their Philadelphia Bridge Works, at Pottstown, Pa. This extension will make the main shop 500 ft. long.

The Missouri Car and Foundry Co. has about finished a new shop in the southern part of St. Louis, and has transferred the work there from the shop at Cambridge City, Ind., which it has leased since the burning of the old shops in East St. Louis.

The firm of Graff, Bennett & Co., at Millvale, Pa., are adding to their iron works a new blacksmith shop. A machine shop and four new puddling furnaces are added to the puddling department.

B. F. Spinney & Co., of Lynn, Mass., have set two tubular boilers on the Jarvis system.

Westboro', Mass., is to have a broom manufactory.

The Lawrence Manufacturing Company of Lowell, Mass., have just set four steel boilers with the Jarvis Patent Furnace.

The Delaware, Lackawanna and Western, and Delaware and Hudson Canal Companies have voluntarily advanced the wages of their men ten per cent. It is thought the Pennsylvania Coal Company, which also employs a large number of men, will follow suit, and that a corresponding advance in wages will be made by the Lackawanna Iron and Coal Company, the Dickson Manufacturing Company and numerous other Scranton industries.

A large new factory building is to be located at Newark, N. J., for George B. Jenkinson, for the manufacture of bag frames.

The Enterprise Manufacturing Company, of Philadelphia, are to make additions to their premises at a cost of $75,000.

The Cutler Manufacturing Co., Warren, Mass., have decided to build a large brick mill on lot just south of their present manufactories. This new building is to be 250 feet long, 80 feet wide, and two stories high, and is to contain thirty thousand spindles. The work of laying the foundation will be commenced immediately, and the whole enterprise will be pushed as rapidly as the weather will allow.

The Rhode Island Locomotive Works, at Providence, are to build 25 engines for the Manhattan Elevated Company.

Phineas Jones & Co., of Newark, N. J., carriage manufacturers, have just purchased a piece of property adjoining their works, and soon expect to put up additional buildings, as next year they intend to increase their production of carriage wheels one-third.

It is said that a party from Hotchkissville, Conn., in the interest of English capitalists, have been looking at the shoddy mill at Sandy Hook, with the view of purchasing the property for the manufacture of cutlery, employing about two hundred men.

Oliver Wilson, J. Martin Yardley and Howard C. Smith have formed a copartnership for the purpose of manufacturing hosiery at Philadelphia, under the firm name of Wilson & Co.

Nealley & Son, of Bangor, Maine, have laid the foundation, and in the spring propose to erect a steam shingle mill. The mill will be thirty by fifty feet, and will have a twelve inch cylinder, which will run four single machines.

Landers, Frary & Clark are building an addition to their iron foundry at New Britain, Conn., which will soon be ready for business.

It is rumored that a number of capitalists of Boston, Worcester and Woonsocket and elsewhere are to form a new rubber company and are to locate their works at Woonsocket, R. I.

A fine grist mill is to built at Kent, Ohio, next season.

The Eaton, Cole & Burnham Company of Bridgeport, Conn., are about to build a large foundry.

A company with $50,000 capital has been organized at Bangor, Maine, for the manufacture of an "endless" mowing machine, about which much is promised.

A new grain elevator, of the capacity of 500,000 or 750,000 bushels, is to be built in Philadelphia, at the Washington street wharf. The structure is to be completed by next fall.

J. Hazlett & Co. have made arrangements for erecting a bolt works in Allegheny, Pa. The building will be 180x80 feet, and employment will be given to about 100 men.

Mr. Jacob Reese, of Pittsburgh, Pa., and citizens of Monongahela City are negotiating with reference to the erection of a hoe factory in that town by the gentleman named, the factory to have a capacity of 1200 dozen hoes per day.

At the Pennsylvania railroad shops at Altoona, Pa., the men have resumed ten hours per day, and have an opportunity also to make something by overtime work.

Hoffman, Billings & Co., Milwaukee, Wis., expect soon to move into their new shops, and contemplate adding a new foundry building, 50x100 feet, next year.

By the fire in the school furniture factory of D. H. Andrews & Co., Chicago, 200 to 300 workmen were thrown out of employment. Nothing remained of the factory and its contents but bare walls. Loss, $50,000; insurance, $35,000. The establishment was probably the largest of its kind in the country, and will doubtless be rebuilt.

The stockholders of the Florence Building Association have sold the buildings known as the Sheffield foundries to B. M. Couch, of Northampton, Mass. The amount paid is a merely nominal sum, the stockholders willingly selling it low to induce a new enterprise to locate in the village. Mr. Munn, of Northampton, will probably occupy part of the building to carry on the foundry business. The new proprietor will not move out for a month or two, as the lease of the plac he now occupies does not expire until February. Some forty men will be employed in the new works.—*Boston Jour. of Commerce.*

E. Parker, of Albany, and others, are about to start a boot and shoe factory at Petersburg, N. Y., in a building formerly occupied by A. L. Stillman, for manufacturing purposes.

Mr. Lawlor, of sewing machine celebrity, is actively canvassing in this city his scheme for a company to erect a large sewing machine factory at Hochelaga, and it is said that his efforts are meeting with encouraging success.—*Montreal Journal of Commerce.*

The Lincoln Cotton Mills, Lewiston, Me., resumed opperation Nov. 1st, after being shut down for two years.

The Barker Cotton Mills of Auburn, Me., are very busy, running to nine o'clock every other night.

The Lewiston (Me.) Machine Company are running on full time, and are very busy on orders for five hundred looms, pulleys, shaftings and hangers for mills in Georgia and Alabama. Of late years they have shipped a great many looms to the south, and have gained a good reputation there. An advance in wages is expected soon.

Morris, Colwell & Page, of Cohoes, N. Y., are putting in a new squeezer and building two additions to their already extensive iron mills.

Campbell & Clute, Cohoes, N. Y., have taken additional orders for five flat-ribbed frames.

John Scott is putting an addition to the Enterprise Knitting Mill, Cohoes, N. Y.

The Dale Mills, opposite the Erie depot, at Paterson, N. J., and one of the largest and finest in the city, has been bought by John D. Cutter of Newark, for $92,000, and will shortly be stocked throughout with silk machinery for manufacturing silk twist and weaving broad silks. This mill was erected by the late Thomas N. Dale in 1865, at a cost of $150,000, and at that time was the largest silk mill in the United States, being calculated to accommodate 1000 hands. It has been only partly occupied for several years. —*Jersey City Evening Journal.*

The Leffel Turbine Water-wheel Works are running their large boring mills till 10 o'clock every night.

The Springfield, Jackson & Pomeroy Narrow Gauge Railroad are putting in some new machinery, including a locomotive tire lathe, built by the Niles Tool Works, Hamilton, Ohio.

On a recent trip through the West, we found one machine shop manager who emphatically has an eye to convenient arrangement, as an aid to rapid and economical business. It was the establishment of the Niles Tool Works, Hamilton, Ohio. The main shop is rectangular in shape, or to use a less technical term, is shaped like a brick (and, by the way, almost every man about the place is a brick, too), and is divided by a row of posts which run the whole length of the shop, and practically fence off about one-third of the ground space in the building, the narrow strip being devoted to small tools and small work, and the large one to handling heavy or bulky work. The wide portion is traversed (near the roof) throughout its whole length, by two traveling cranes, or carriages, on each of which the name of an eminent and dignified citizen is painted, as a means of distinguishing the two, doubtless, while honoring the e. and d. citizens aforesaid. Having forgotten the names, we trust we shall not be deemed irreverent, if we dub the two travelers Moses and Aaron respectively. By means of these cranes, every square inch in the wide portion of the shop is easily accessible to every other part. For example, if a heavy machine or casting, surrounded by no matter how many other heavy machines or castings, is to be removed to any other part of the shop, Moses or Aaron, as the case may be, is trundled up directly over the spot, a substantial chain is gripped round the article to be moved, and in the twinkling of an eye, almost, the refractory article is "yanked" high in air, trundled off to the point opposite its destination; the other crane, as the case may be, lowers a chain, seizes the machine, while the small carriage gaily slides off sideways with the machine in its grasp, and then the work of trundling off to the required spot and dropping anchor on the precise square inch desired is a work of only a minute or two.

Next door to the Niles Works is the Cope & Maxwell establishment. These two big shops lie along side of each other as sociably as a pair of twins, each being devoted to a different line of business. The Cope & Maxwell people make a specialty of steam pumps, and are said to make the largest variety of pumps made by any one house in the country (although we did'nt stop to count the styles), pumps for deep mining purposes, constituting an important specialty. These latter appliances go largely to the far western states and territories—Wyoming, Montana, Colorado, Nevada, etc. Altogether the establishment appears prosperous, as every wide-awake, progressive shop must naturally be, and is a credit to Ohio and the West.

Our recent note regarding the new saddlery hardware factory (goods made of a new white metal), recently started at 44 Centre street, New York, by Calvin Carr and associates, should have read, "the Markland & Poole Manufacturing Company have started," etc.

A subscriber from Springfield, Ohio, writes:

Warder, Mitchell & Co. are building an addition to their large shop, 60x100 feet, making it 400 feet long. They manufacture the Champion Reaper and Mower. They employ 450 hands, and are putting in some new machinery, including 100 feet of line shafting. They are now running 8½ hours time, and were 1500 machines short last year.

Roberts & Myers, Springfield, O., have built a large foundry and machine shop, and run till 10 p. m., every day, and sometimes all night.

The Champion Malleable Iron Works are putting in several furnaces, in addition to their annealing rooms.

Machinists' and Engineers' Supplies.

NEW YORK, Dec. 4, 1879.

Things are pretty steady in this department, and not much disposition to change prices one way or the other, except in small items, until after the first of January.

The Rubber Belting men met yesterday, but made no change in prices, and will probably make none during the remainder of this year.

Peter A. Frasse & Son, 95 Fulton Street, N. Y., have received a stock of Demas Scroll Saws, said to be very scarce in this market.

Boxwood and other Rules have been again advanced.

Flat Head Iron Wood Screws have been advanced to wholesale discount of 50% from list.

Henry Whiton has withdrawn from the chuck business, possibly because he found himself in too close chuckstaposition to stiff competitors. Probably the latter chuckle somewhat over the occurrence.

Manufacturers of machine tools, who design making changes in prices at the beginning of the new year, are especially invited to send us notice of same in advance for publication in this column.

Iron Review.

NEW YORK, Dec. 4, 1879.

There is no change in quotations whatever to note since our last week's report, though the conviction is freely expressed by well-informed iron men that a material advance is bound to take place between now and next spring, if not directly after the first of January. Late advices from England report an excited feeling there regarding prices, and the tendency is upward. Here the speculators are thinning out, and while prices of raw iron may fluctuate somewhat, the general result is not affected. A great number of consumers have deferred buying in expectation of lower prices, and the demand from such parties after January 1st will tend to stiffen rates.

A. B. Warner & Son, 28 West St., New York, quote Boiler Makers' supplies out of store: Tank Iron, 4½c.; C. No. 1 Boiler Plate, 4¾c; C. H. No. 1 ditto, 5c.; Best Flange ditto, 6c.; Boiler Rivets, 5 to 6c.

Pierson & Co., 24 Broadway, New York, report prices of other Iron Supplies out of store:

No. IX Pig, $30 to $31 per ton; Iron Rails, $50 to $60, according to weight; Old Rails, $31.50 to $32; Fish Plates, 3c. per lb.; Railway Spikes, 3¾c.; Bolts and Nuts, 4½c.; Common Bar Iron, 3c., basis from store; Refined, 3 2-10c., basis: Ulster, 3 8-10c., basis; Machinery Steel, 7c.; Best Tool Steel, 12½c.; Norway Bar Iron, 5¾c.; Norway Shapes, 6c.; Nail Rods, 6 to 6½c.; Sheet Iron, 4½c., basis; Angle Iron, 4c.; Tee Iron, 4½c; Band Iron, 3 6-10c.; Hoop Iron, 3 8-10c.; Horse Shoe Iron, 3 8-10c.; Hot Polished Shafting in lengths, 2 ft. and longer, 7 to 8c., according to size; Small Black Rivets, 50% off in papers, 35% off in bulk.

Metal Review.

LUCIUS HART & CO., 8 & 10 Burling slip, New York, furnish us the following, under date of Dec. 4th, 1879:

The market is dull and steady for metal, London, £93 for Straits Tin. We quote as to-day's prices: Banca Tin, 24c.; Malacca and Straits, 21½c. to 21¾c.; Billiton 21½c.; "Lamb and Flag," stronger, 21c.; Pig Lead strong on small business, 5¾ to 6c. as to parcels. Antimony, 16½c. for ordinary brands; Cookson, nominal, 20c.; Spelter, 6¼c. for Domestic; Foreign ("S. S.," brand), 6¼c.; Ingot Copper, 21¾c. spot, 22¾c., future deliveries. Nickel, $1.25 to $1.50. Bismuth, $2.50; Solder, No. 1, 11¾c.; "Half-and-half," 13¾c.

Situations Wanted—Help Wanted.

We will publish notices suitable for the above headings, applying to any of the machinery trades, and not to exceed four lines each (32 words), at the nominal rate of twenty-five cents for each insertion.

Position wanted as draughtsman by a practical mechanic; experienced in designing, perfecting, and superintending construction of special machinery. Address, D. C. A., office of AMERICAN MACHINIST, 96 Fulton street, New York.

Situation wanted as a Foreman Boilermaker by a Scotchman with best of recommendations. Has been foreman over six years. Address, BOILERMAKER, office of AMERICAN MACHINIST, 96 Fulton street, New York.

Wanted a situation as Loam Moulder by a young man just from England, 8 years' experience on first-class work. Address, Isaac Goostray, Concord, N. H.

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Sale to commence at 1 o'clock P. M., when conditions will be made known by GEORGE S. CAPELLE or ALLEN GAWTHROP, Committee, Wilmington, Del. Please send for Catalogue.

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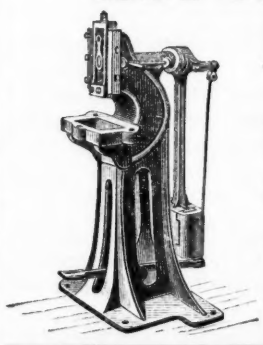
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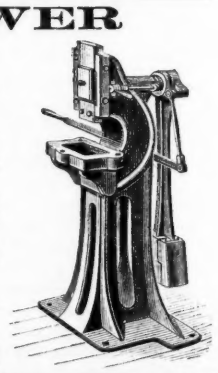

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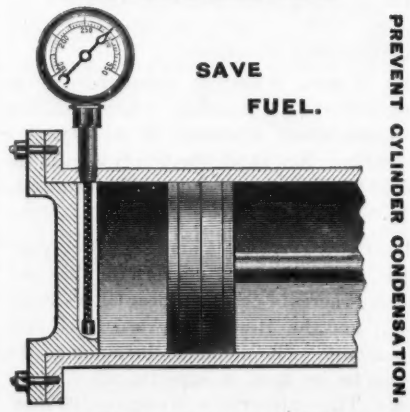

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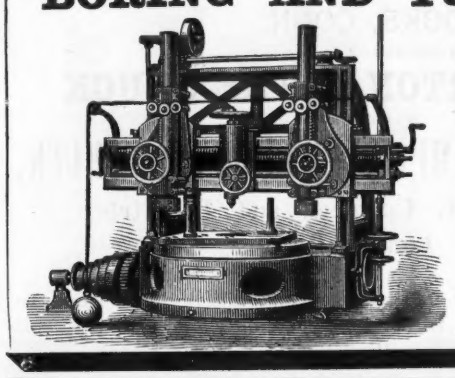

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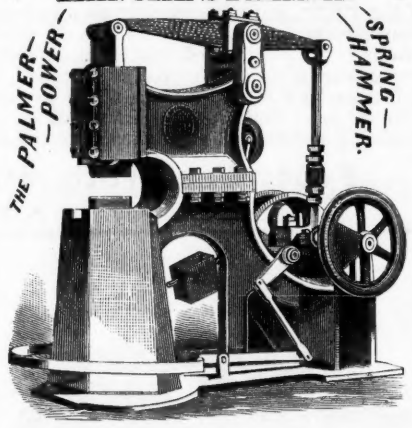

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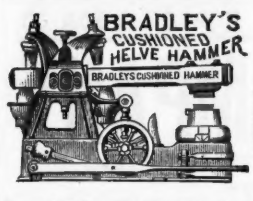

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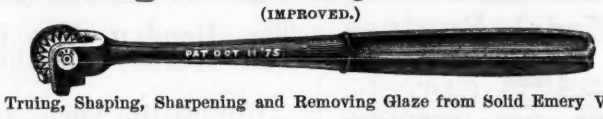

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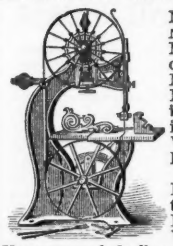

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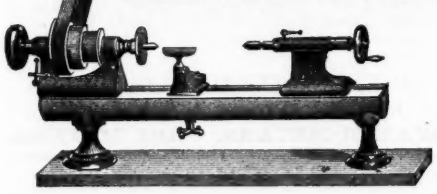

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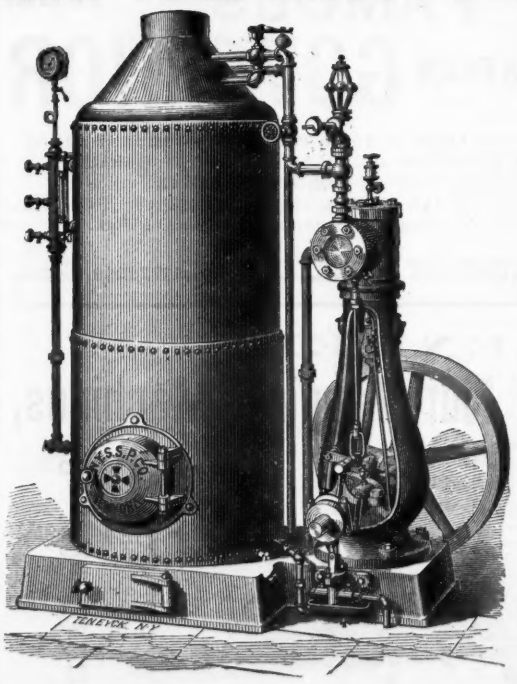

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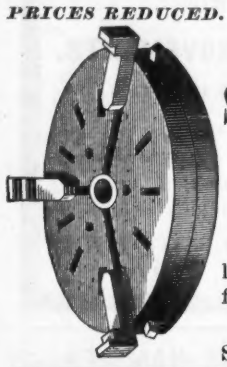

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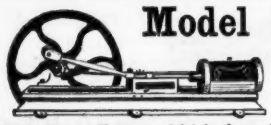

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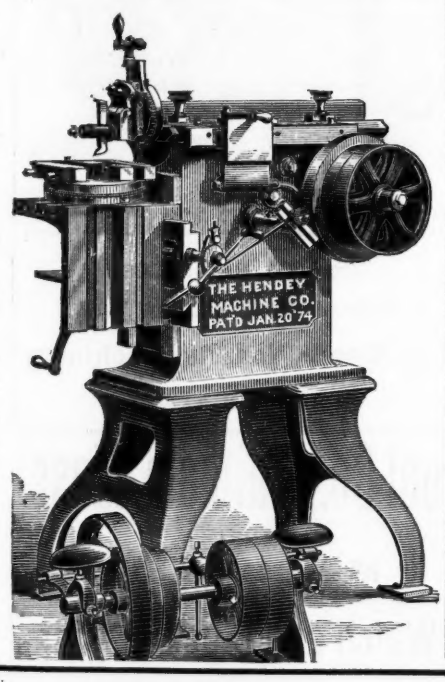

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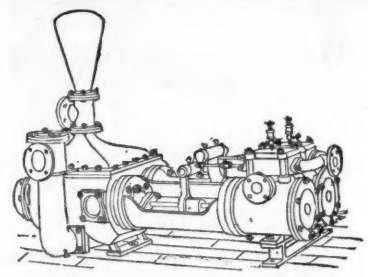

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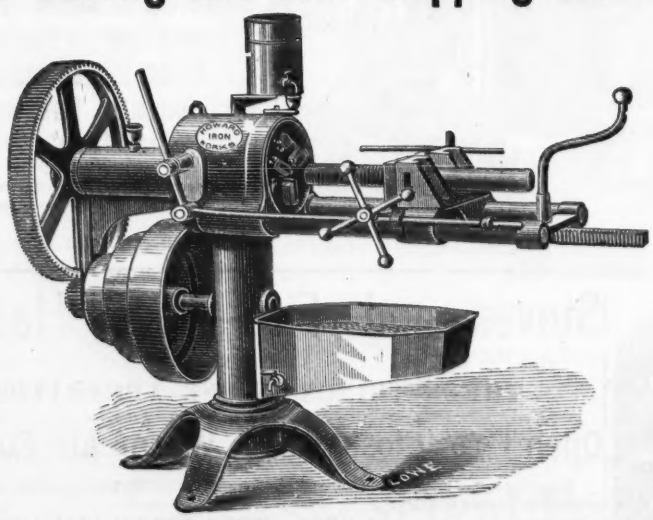

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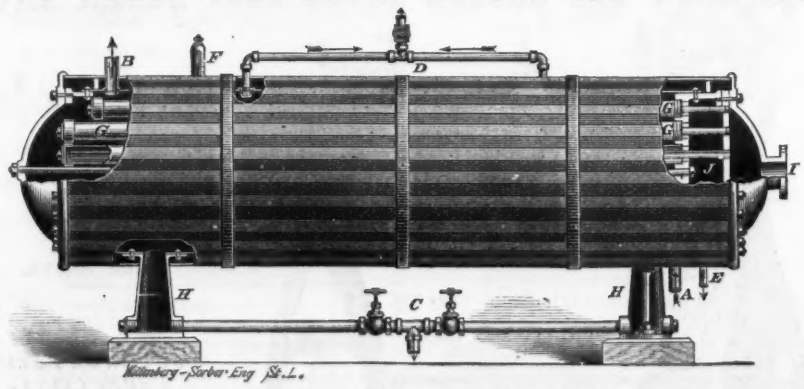

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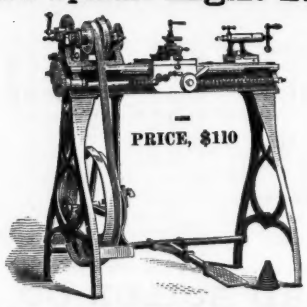

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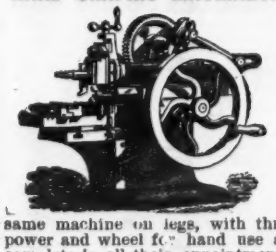

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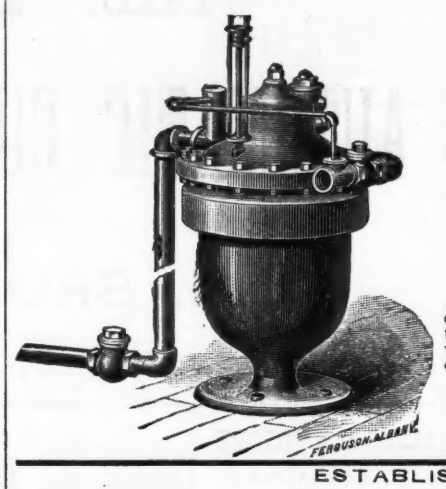

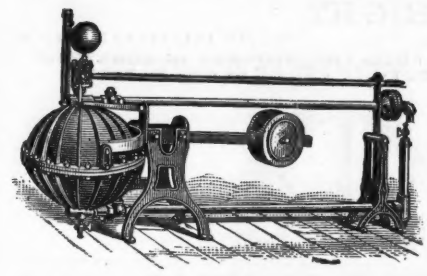

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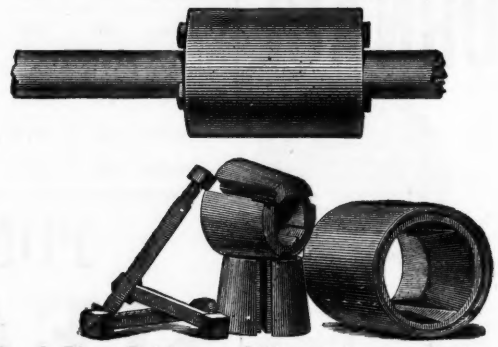

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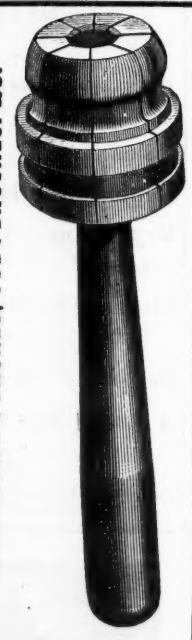

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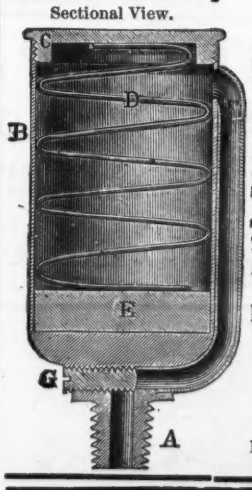

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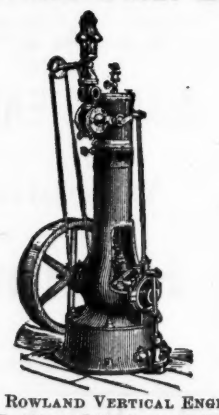

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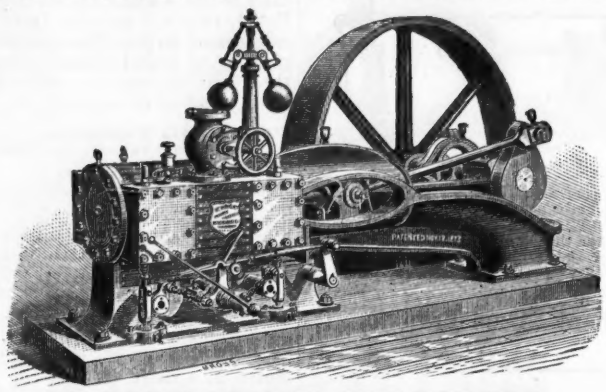

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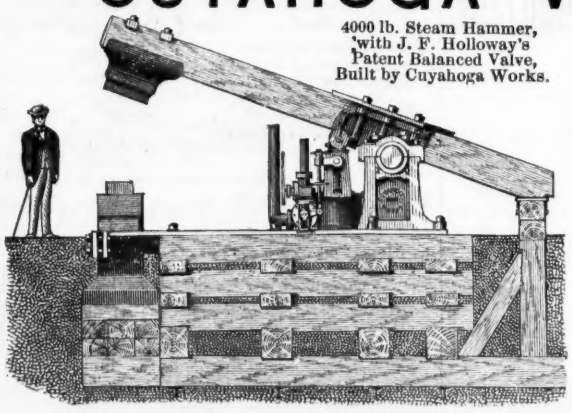

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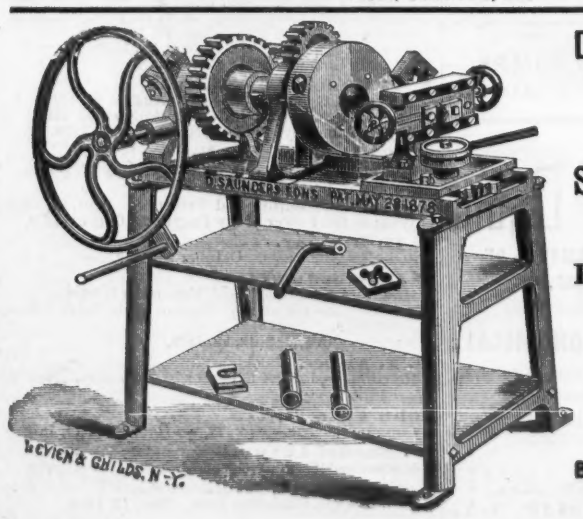

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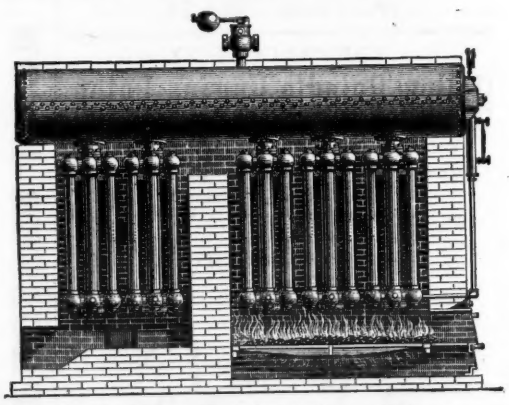

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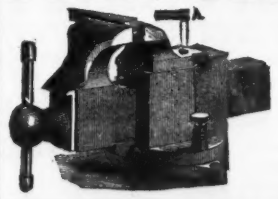

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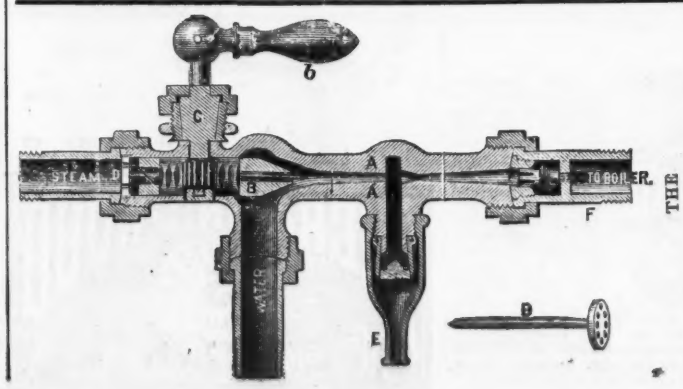

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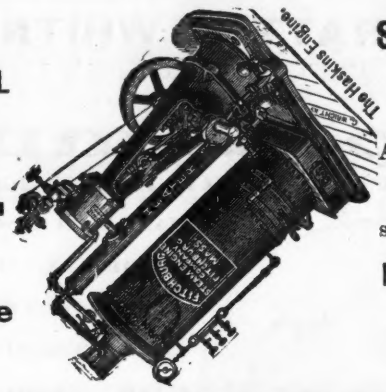

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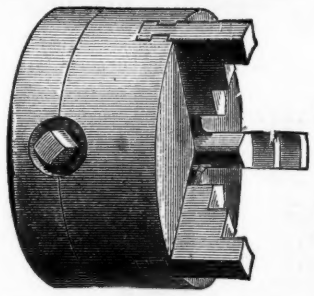

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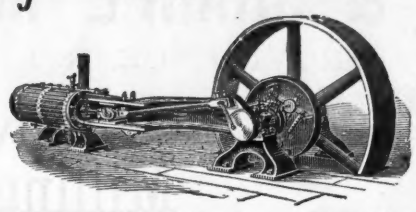

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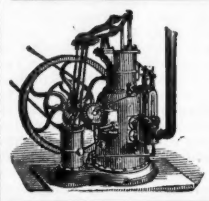

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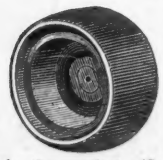

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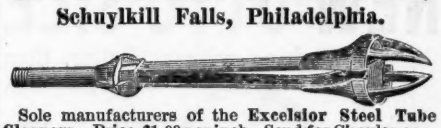

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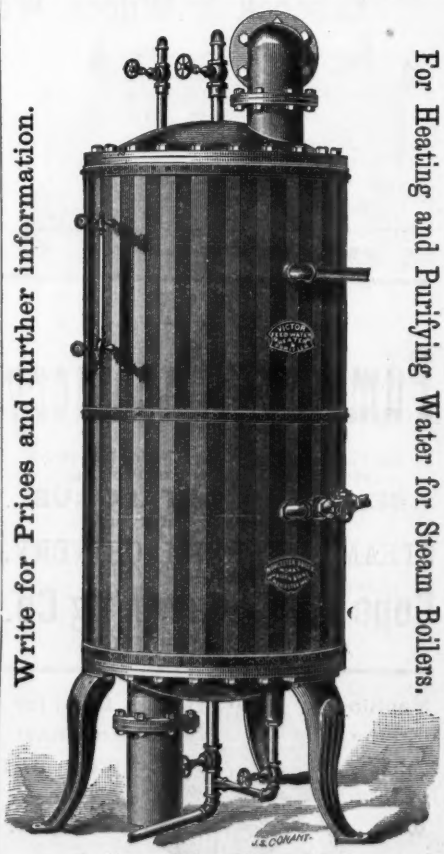

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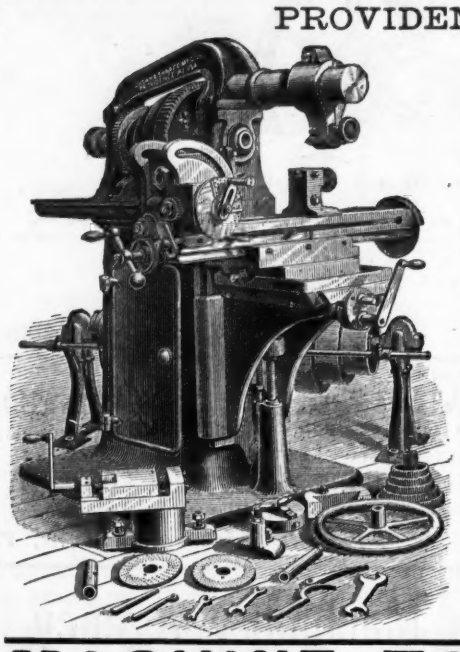

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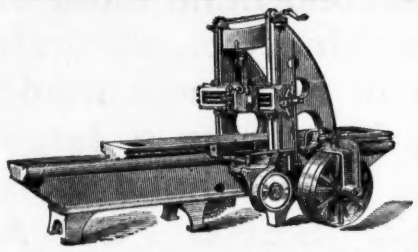

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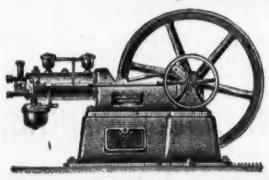

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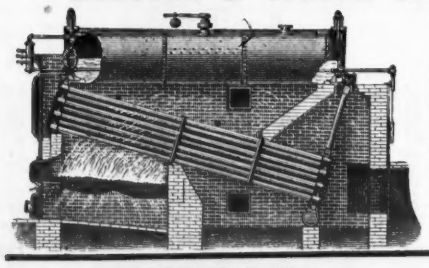

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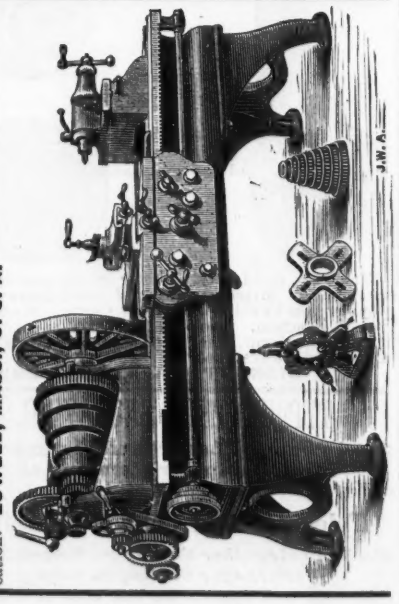

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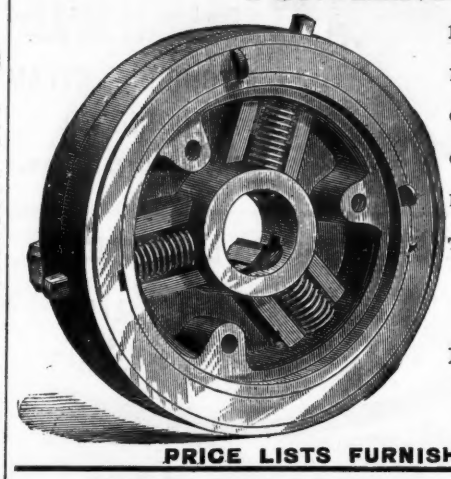

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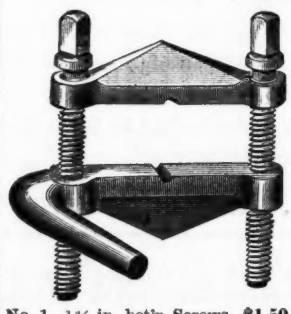
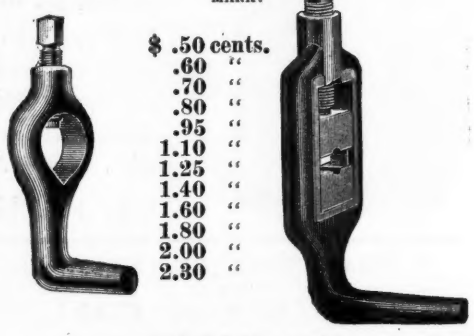


⅜	inch...	$ .50 cents.
½	" ...	.60 "
¾	" ...	.70 "
1	" ...	.80 "
1¼	" ...	.95 "
1½	" ...	1.10 "
1¾	" ...	1.25 "
2	" ...	1.40 "
2½	" ...	1.60 "
3	" ...	1.80 "
3½	" ...	2.00 "
4	" ...	2.30 "



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Per set of three, ... 5.50

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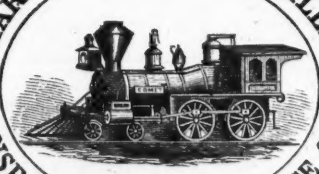

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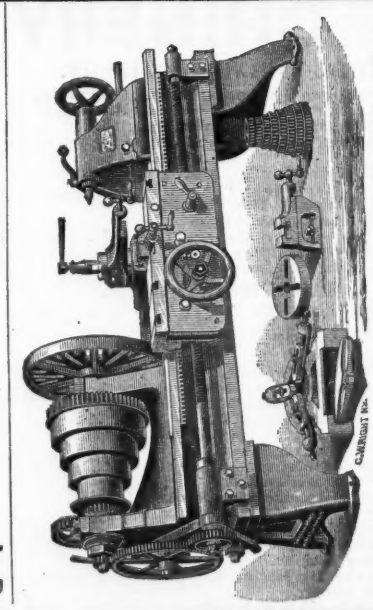

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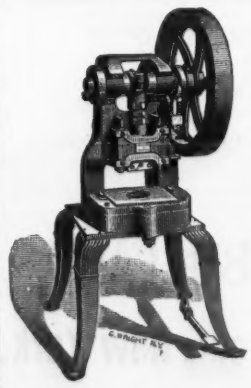

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